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THE

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THE LEGAL POSITION OF A TRADE UNION.

IN a recent issue we dealt at some length with the alterations made in the law affecting Trades Unions, by the Taff Vale Railway case. For that purpose we drew attention to some of the instances where damages have been recovered by workmen who were kept out or deprived of employment by the illegal acts of Trades Union officials; but we made particular comment upon one case which went to show that the Union cannot in all cases be held responsible in damages for the act of an official. A study of these cases might have aided the discussion anent Trades Unions which took place in the House of Commons on May 15th. On that day Mr. Beaumont moved that legislation was necessary to place the Unions in the position which they were intended to occupy by the Act of 1871. He and his supporters bitterly complained that the rights and privileges of these bodies have been seriously impaired by judge made law; that there is one law of conspiracy for the master and another for the servant; and that, unless measures are taken to limit the liability of a Trade Union funds set apart for the orphan and the widow may be drawn upon to make good the damage occasioned by the wrongful and unauthorised acts of irresponsible members. So many fallacies underlie these statements of law and fact, that there is a difficulty in setting them out in small compass. Nevertheless, with the assistance of our leading article in last week's issue, it is possible even for the non-legal mind to see that the case for the trades unionists has been grossly exaggerated. In the first place, it is wrong to say that the judges have altered the law. Their function is to interpret statutes, not to lay down new principles; and if the Unions have escaped for more than 30 years from the consequences of unlawful picketing, their feeling towards the judiciary should be one of gratitude. But in what respect do the Unions contend that their rights and privileges have been impaired? They complain that the peculiar form of persuasion known as "peaceful picketing" has been declared illegal; but it is a notable fact that few advocates of trades unionism are bold enough to try and defend the methods which were adopted in certain cases since the Taff Vale Railway dispute. Such methods involved in one case the driving of an unfortunate artisan from factory to factory all over the kingdom, until he and his family were well-nigh starved, and ultimately led to a verdict against the Union at the hands of a jury. It is astounding that anyone can be found to advocate an alteration in English jurisprudence which would bring such conduct within the law. It is also said—we suppose by persons who have never looked at the statutes relating to Trades Unions—that recent changes in the law place masters and men upon a different footing in so far as the law of conspiracy is concerned. It is sufficient to point out (1) that the definition of a Trade Union includes a combination of masters as well as a combination of men; and (2) that the

principles so clearly enunciated by the House of Lords are not aimed solely at trades unionists, but against all persons who conspire together to interfere with freedom of contract, and to restrain trade by unlawful means. Thus, if it could be shown that a combination of employers was formed to boycott some particular man and so prevent him obtaining employment, it is submitted that assuming the combination was capable of being sued, a successful action might be brought. Last, but not least, the advocates of trade unionism complain that their sick funds may be attacked. The remedy is obvious, and it lies within their reach if they only choose to grasp it. We refer, of course, to the severance of sick and strike funds. As was pointed out in the course of our last article, every Union has persistently refused to adopt this course. Another plea *ad misericordiam* remains to be noticed. It is said that the acts of an irresponsible member may mulct the Union in heavy damages. All who have read a recent judgment of Mr. Justice Walton in a Trade Union case tried at the Manchester Assizes, will appreciate the falsity of this assertion. There an action was brought against a Union and their general secretary jointly. Judgment was entered against the secretary in his private capacity, but the learned judge held that although he was authorised to do many acts on account and in the interest of the Union, his implied authority could not be held to extend to the committal of unlawful acts. In the light of this ruling how can it be argued that the acts of an independent member are a standing menace to the Union funds?

Nitrogen from the Atmosphere.

THE Atmospheric Product Company, of Niagara Falls, has been incorporated with a capital stock of $1,000,000. The directors named are C. S. Bradley, W. E. Knight, W. F. Crawford, H. E. Knight, D. J. Newland, C. von Gruever and W. P. Hammond, all of New York City. The company, it is stated, has succeeded in the fixation of nitrogen, taking the atmosphere as the raw material. When Lord Kelvin was recently in the States, he spent half a day in the experimental quarters of this company at Niagara Falls, and witnessed the success accomplished. He is said to have stated that it was the most remarkable thing he had seen during his visit; he was deeply interested, and it has been intimated that one of the main objects of his going to America on this third visit was to examine into the claims made by the men at the head of this company, which was incorporated while he was in America; in fact, just after he had witnessed the success of the process.

While the Atmospheric Product Company will erect its first factory at Niagara Falls, only a single commercial unit is in operation now. The fixation of nitrogen on a commercial scale has long been a subject of research in the scientific field. In 1785 Priestley discovered that when an electric spark was discharged, the air immediately surrounding underwent a chemical change, and later the experiments of Cavendish agreed with the findings of Priestley. Since then the problem has attracted much attention—our readers will remember Prof. Crookes's B.A. Presidential address in 1898—and now we are told that the fixation of nitrogen is an accomplished fact.

In the experimental station at Niagara a chamber about 10 feet high is used, and through this, cool, dried air is led. This air is made to pass through a region where electric arcs of small current and high pressure are discharging, and it is about these arcs that the chemical change in the atmosphere takes place, giving rise to brownish red gaseous substances, oxides of nitrogen. From the chamber the air is led to an absorption tower, where it is brought in contact with any substance of which a nitrate is desired. It is stated that by leading the gas through pure water, pure nitric acid results, and if it is led into contact with caustic potash it forms saltpetre. In contact with caustic soda it becomes Chili saltpetre. With scores of substances it forms salts of great value in a thousand ways and to a thousand arts. It is said that the company hope soon to see starch manufactured in their laboratory. When this is done the result becomes of value to the food products of the world, and it is already prophesied that the company's product will, when used as a fertiliser, have a material influence on the future wheat crop of the world.

Duties of Tramway Companies.

IN the case of Rattee *v.* The Norwich Electric Tramway Company, which was heard in the Court of Appeal on April 29th, and which was duly reported in these columns in our issue of May 2nd, an attempt was made to limit the liability of an electric tramway in a way which the most fiery advocate of electric traction can hardly support. An action was brought by the owner of a horse and trap to recover damages for injuries alleged to have been caused by the negligence of the defendants or their servants. It was contended on the part of the defendants "that there was no duty cast upon their driver to stop the tramcar or to slow down on approaching the trap, as the tramway was being worked under statutory powers." Lord Justice Vaughan-Williams disposed of this argument in the following words:—"What is authorised is the use of tramways on the highway in a proper manner and taking proper care. . . . . Here, although the tramway company's Act authorised them to do what otherwise would have been a nuisance, it does not free them from the obligation to make a proper use of their powers." Attempts to escape liability, when founded upon arguments of this kind, do much to discredit electric tramway service. While meeting the needs of their multitudinous passengers, those who have the control of electric tramway systems must not forget to remind their drivers to respect the rights of other liege subjects on the highway.

A Blind Leader.

FOR reactionary and pernicious tendencies, a leading article published last week by one of our contemporaries, on the subject of electric traction, would be hard to beat. The writer "presumes," to use his own word, that the early tramway companies obtained their Parliamentary powers by virtue of the absence of opposition, and established precedents which enabled wealthy promoters to do practically what they would, until the "poor, long-suffering public" was discovered, and tramway work "rendered almost impossible by limitation of time of ownership." But who benefits by the services of the tramways? If not the public, who then? Doubtless the promoters sometimes made a profit, to which they had a just right, as a reward for their enterprise and the risk of their capital—but in point of fact, too often the profits were *nil*, in which case absolutely the only persons to profit were "the long-suffering public!"

Proceeding to point out that tramway traction interferes with the general use of the streets, and ignoring the fact that the tramcars are a means by which the public make use of the streets, the leader-writer argues that tramways should be constructed on their own ground, unless they are guiltless of interference with traffic. Where, we would ask, is it possible to carry out this extraordinary notion in modern cities? and how is the network of *public* streets to be crossed by the private tramways? Overhead, or under-

ground? How many tramways would be constructed under such conditions? To judge by the eagerness which the public authorities are manifesting to get possession of the tramways, and to construct new ones, the public is not in agreement with this writer. He goes on to complain of the proposal to construct tramways along the Thames Embankment, which is "not at present seriously overcrowded" (apparently he would prefer them to be laid only in crowded thoroughfares), and suggests that the scheme is really intended as a means to obtain future powers to cross the bridges. We dispute the inutility of the present scheme; but if it leads to what our contemporary fears, we shall be only too pleased. Lieut.-Colonel Crompton's extravagant assertion, to the effect that tramways are about the worst means of transport of passengers, is solemnly quoted. We maintain that, compared with electric lighting, which only benefits a fraction of the community, electric tramways are far more useful to the general public, and we earnestly deprecate the utterance of such antiquated and misleading statements.

Made to Standard.

Much has been written and much remains to tell of the subject of standardisation. In America there are some excellent habits. Thus there is a Master Carbuilders' Association, at the meetings of which the design of standard parts of cars and trucks is discussed, and standards are fixed upon. This is but one example of how things are standardised. Let us look at the subject in view of what can be done in any trivial article in use in Great Britain. We shall take the item of overhead material for electrical tramway work. The large extension of overhead work in America has brought American overhead material into considerable use here, and all our overhead material is practically modelled on the types evolved in America; there are now numerous makers of ears, pull-offs, strains and the other brass work with which we are all familiar. There is not much amiss with the patterns evolved in American practice, and these patterns are made on this side too, sometimes in a quality superior to the American stuff, at other times in a quality much worse. We have seen both varieties. Now, it is a fact, that makers of this overhead material, brought down as it is to standard forms, cannot make to stock owing to the differences in trivial detail demanded by local engineers. This ought not to be the case. Two or three lengths of ear are ample for all purposes, and, given good material, no engineer ought to expect to have such trivial details specially made to suit him. We recently heard of 12 heavy castings being refused by a Westminster engineer because of some small difference in form. The difference was so trivial that the unfortunate contractor had not, as he said, the cheek even to pass on the complaint to the firm who sold him the article, and his profit disappeared. Another firm stated that they never had made any profit when they had done work under a certain Westminster engineer. Has not the time arrived for contractors to form an association to protect themselves against the vagaries of Westminster, publishing the fullest information of all unreasonable demands, and refusing to tender for such work as is subject to needless variations?

The worst is that these crude efforts involve special manufacture, new patterns and delays, and that the unfortunate contractor, who could do a better job in quick time with the best and most improved type of material, is run into the risks of penalty and forced to produce an antiquated piece of work with materials made on old patterns not properly suited to the work. Indeed, some engineers get run into a corner with their vexatious and impossible demands, and being unable to get what they want in time, they then order stuff from America absolutely without inspection or specification, and they get, of course, a cheap article of poor durability. Then we hear of it in the press, but the daily press never knows the full reason.

INFLUENCE OF TEMPERATURE ON THE CAPACITY OF ACCUMULATORS.

By W. HIBBERT.

CONTINENTAL workers have recently given much attention to the question of a temperature variation in the capacity of accumulators. Schoop (*Electro. Zeits.*, 19, p. 353, 1901), Heim (*El. Zeit.*, 22, p. 811), and Liagre (*Eclair. Electr.*, 29, 149), have each discussed extensive series of experiments made by themselves. They confirm the results obtained by Dr. Gladstone and the present writer in 1892 (*Jour. Elec. Engrs.*), that a rise in temperature causes a marked increase in capacity. It may be interesting to give some of the figures obtained by the Continental workers. The use of accumulators is extending, and the many engineers who are brought in contact with them will find suggestive help in the results. For example, Liagre points out that, although it was shown nine years ago that a large increase of capacity occurs at higher temperatures, no one thinks of mentioning the temperature for which the capacity of a cell is quoted. It would be quite easy in testing a cell, say, at 25° C. (= 77° F., a summer temperature) to obtain a capacity more than 20 per cent. higher than at 15° C. (= 59° F.). Heim found the increase in capacity equal to 3 per cent. per degree, using Hagen Company's cells of two types, a figure much like that obtained by Gladstone and Hibbert. This is a very high rate of increase, and it is evident that, where it holds good, a few degrees difference in temperature will make a deciding difference in capacity. But Liagre, who seems to have worked most systematically, shows that the percentage increase in capacity depends on the discharge rate, and increases with it. He obtained 2·7 ampere-hours extra for each degree Centigrade rise of temperature. As this was true at all discharge rates, it was a higher percentage of the whole discharge with strong currents than with weaker ones, seeing that the capacity is lower with the former.

Heim's figures for five large cells, working at a three-hour rate, are represented in the following short table:—

Temp.	Amperes.	Ampere-hours. Charge.	Discharge.	Efficiency.
12°	140	437	386	0·88
45·9	140	896	735	0·82

This indicates an increased capacity of 100 per cent. The changes of potential difference during charge and discharge are shown in figs. 1 and 2, the data referring to a smaller cell

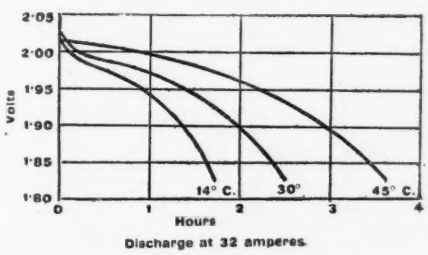


FIG. 1.

discharging at 20 amperes. The charging volts do not rise so high at the higher temperature, and are a little higher during discharge. In consequence of this the energy efficiency is not so much affected as the quantity efficiency.

There are some other observations which ought to be mentioned. At high temperatures the acid density diminished in a greater degree than at low. By charging at a lower, and discharging at a higher temperature, a greater number of ampere-hours could be got out of a cell than were put in. Or a discharged cell could, by warming, be made to yield a further discharge.

All these results are easily explained by the theory which ascribes the varying E.M.F. to the varying strength of acid in the pores of the active material. At the higher temperatures the acid diffuses in or out of the pores the more quickly. Hence, it can more quickly replenish the spent acid during discharge and so keep up the E.M.F. Similarly strong acid can more quickly diffuse out during charge, and the E.M.F. never rises so high. At the ordinary tempera-

tures the diffusion rate is too slow to keep up the acid strength when about half or one-third of the active material has been changed to sulphate, owing to the partial clogging of the pores. But at higher temperatures the diffusion rate is able to keep up a sufficient acid strength in the pores till a much greater degree of clogging has occurred.

It is, therefore, evident that with quite a moderate increase in the temperature of the accumulator room, a largely increased capacity may be looked for, and it becomes important to ask whether engineers ought to utilise their waste heat in that direction. Heim thinks they ought. He imagines that if a rise of temperature injures the plates, the injury will not be serious. He, therefore, advises that

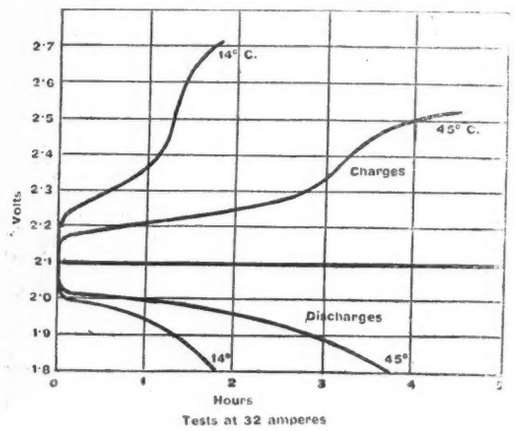


FIG. 2.

engineers can temporarily increase the capacity of their cells by warming. If their experience proves this to be injurious, he would still adopt it for emergencies when a specially heavy discharge is required. Heim excludes tramway cells from this treatment, because they already experience excessive discharges.

Now if these opinions of Heim's stood alone, they might influence many users of cells. But he candidly states that the Hagen Company do not agree with him. Their experience is that accumulators which happen to work in warm stations are injured by the high temperature. Manifestly it would be to the company's advantage if they could obtain the higher capacity due to higher temperature. But they cannot resist the evidence of experience.

Nor are we dependent on that experience. In our 1892 paper Dr. Gladstone and I not only showed that capacity could be increased 40 or 50 per cent. by warming, but pointed out that "the increased temperature would increase local action, and the (direct) chemical action of the acid upon the spongy lead." Here were two definite objections to warming: local action on the positive plate, direct sulphating of the negative. Our results explain the diminished ampere-hour efficiency found by Heim, and also the cause of the injury of which the Hagen Company speaks.

These objections are reinforced by plenty of evidence contained in the records of the past. Thus Planté pointed out that elevation of temperature facilitated the formation of his cell (*Compt. Rendus*, August, 1882), and Gladstone and Tribe proved that this increase arose from increased local action. In their little book on secondary batteries (1883) they describe a large though variable augmentation of local action between 11° and 50° C. In one case the corrosion was nearly three times as great at the higher temperature.

These data will explain why Dr. Gladstone and I emphasised the danger in 1892. Yet we did not reject the possibility of getting some of the advantage due to higher temperature. We pointed out that the increased action on both plates might be counteracted "by a reduction in the strength of the acid, but we have not tested at what temperature and with what strength the advantage is a maximum." (*Jour. Elec. Engrs.*, 1892, p. 31).

Each maker might well work towards finding these values for his own type of cells. Unfortunately, the work is not easy. Yet till this and similar work has been done, the making and using of accumulators will stand on a different basis from that employed in the design of dynamos and engines.

The reader acquainted with the history of theories of E.M.F. for the accumulator, will find that this work on the temperature capacity coefficient sheds considerable light on some and proves conclusively the unreliability of others.

REFUSE DESTRUCTION: ITS SANITARY AND ITS STEAM RAISING ASPECTS.

By FRANK BROADBENT, M.I.E.E.

THIS is a sanitary question, a point that is apt to be lost sight of by those who try to see in the destruction of refuse only a means of raising steam. It cannot too strongly be insisted that the sole object of a refuse destructor is *to destroy refuse*. The destruction must be absolute, and, in the process, neither harmful nor objectionable fumes must be given off into the atmosphere.

It is strange that the scientific side of the sanitary disposal of refuse has, until recently, received so little attention. It is, indeed, paradoxical in an age when extreme—almost absurd—precautions against infection are taken; when we are told that kisses should not be exchanged except through an antiseptic veil; that it is not safe to correspond otherwise than by telegraph; when everything we eat or wear must be sterilised or disinfected; when one is afraid to accept a railway ticket that has not been fumigated, and so on, that refuse of the most pestilential kind is permitted to be "tipped" in any hole or corner, hollows in land filled up with it in order to make "*desirable* building plots," or it is emptied into the rivers in our chief cities, and into the sea at our most fashionable and "salubrious!" watering places.

Punch might well decline sea bathing because he had "no taste for sewage, diluted though it be." Any incipient taste of this depraved kind would be effectually corrected by a trip up certain portions of the Clyde during the summer months, or a visit, say, to St. Malo Harbour when the tide is out.

It is now beginning to be recognised that the only sanitary method of disposing of refuse is by burning, and by burning is meant, what is generally associated with the word cremation, or incineration. It is possible that the sentimental objection to the cremation of human bodies may be one of the causes which have retarded the development of crematory destruction for other forms of refuse. The cremation of victims to plague, small-pox, or other virulent disease is not yet looked upon as necessary in the interests of sanitation, although it is admittedly advisable to burn contaminated clothing, bedding, and the like.

A glance into the history of the origin of epidemics shows what very grave risks are run by merely burying the victims. It is generally recognised that the great fire of 1666 was one of the best things that could have happened to London, destroying, as it did, many of the infected localities visited by the terrible plague of 1665. Beneficial as was this fire, it was powerless against the germs lying dormant in the graveyards, and almost 200 years later these germs were revivified by the excavation made for sewers, in the site of the old burial ground, with the result that the virulence of the cholera which visited London in 1854 was considerably enhanced, if not actually started.

The plague which visited Madeira early in the 19th century was due to the disturbance of the ground in which, 300 years before, plague victims were interred.

The outbreak of plague in Egypt in 1823 was traced to the opening of a disused burial ground, near Cairo, and in 1843 the town of Minchinhampton was nearly decimated, owing to some superfluous soil from a graveyard being used in gardens as manure.

Such facts as these, in view of the prevailing small-pox visitation, are sufficiently alarming to suggest the question as to why cremation is not more general. The subject is not a new one, and in this, as in other matters, the ancients were ahead of us. As far back as recorded history carries us, the

burning of the dead was practised by the Scythians, Phrygians, North American Indians, and later by the Greeks; and this, for sanitary, not religious, reasons.

About 100 B.C., the practice was common, and was subsequently adopted by the Romans, becoming general towards the close of the republic. Although no religious rite was involved, yet its disuse in Europe was brought about by the Christians living about the end of the fourth century, and it is only in recent years that any serious attempt has been made to revive the custom.

This reference to the cremation of human bodies is somewhat outside the scope of the present article, but the instances cited will, it is hoped, emphasise the fact that the burying or drowning of dead or decayed matter, be it refuse or sewage, fevered swine or cattle, is not to dispose of it finally, for, as has been shown, disease germs may remain in it in a state of suspended animation for hundreds of years, only awaiting a resurrection at the point of the boring tool or the spade of the navvy.

It is not generally realised how dangerous is the practice of tipping ordinary refuse, including filth and decaying matter of all kinds, in heaps upon land that may be subsequently used for building purposes or for public spaces. As was pointed out in 1896 by Mr. E. Magennis, the gases rising up from such matter into dwelling houses, engender such diseases as typhoid, cholera, yellow fever, dysentery, rheumatism, &c.

Two years ago there was an outcry in Dublin against the Corporation for depositing refuse in a field which was within 100 yards of dwelling houses. The stuff consisted of ash-pit refuse, market sweepings, including rotten fish, fragments of carcases of poultry, and other animals, including dogs and cats. The stench was indescribably awful, and ladies half a mile away used their handkerchiefs to protect themselves from it. This is only one instance of many that unfortunately might be cited. Even in hospitals refuse is largely dealt with in the same insanitary way, although in cases of small-pox or other virulent disease, the bedding and clothing of the patients are generally burnt. This practice has probably grown from the custom established by Moses to check the spread of the plague of leprosy.

It may be considered almost a form of affectation to refer to Moses as a pioneer in matters of sanitation; it is nevertheless on record that among many other sanitary laws, he framed special regulations as to the burning by fire of infected wearing apparel.

It is only within the last 30 years or so that the destruction of town's refuse by burning has been seriously attempted. Burning is rather too strong a word to apply to the process obtaining in some of the early forms of furnaces. The stuff was, for the most part, merely stewed or cooked on a fire, the gases passing direct from the grate to the chimney, and thence into the open air, where the escaping germs or microbes, instead of being rendered harmless, were probably just warmed up to their work.

Nothwithstanding the high chimneys used, the smells from some of the early forms of destructor were most offensive, causing both complaints and protests from neighbouring residents. In one town the authorities were forced to buy up the surrounding property in order to stop the complaints.

The temperature of the furnaces used in those days was from 500° F. to 800° F., whereas, according to scientific authorities, a temperature of at least 1,250° F. is needed to render the gases and residuals innocuous.

The "Jones fume cremator," designed by Mr. Charles Jones, one of the pioneers in refuse destruction, formed a link or stepping stone between the low temperature natural draught furnaces in vogue in the eighties, and the modern high temperature forced draught furnaces, as designed by Meldrum, Horsfall, and others.

The "Fume cremator," consisting of an independent furnace burning coke-breeze or coke, was placed in the path of the gases from the so-called destructors, and to some extent completed the unfinished work of the latter.

In the light of modern practice, by such makers as those referred to above, the requirements of a really satisfactory destructor, and the manner in which these are fulfilled, may now be considered.

To fully appreciate the requirements, it is necessary to examine the nature of the stuff to be burnt. This varies very considerably in different parts of the country, and varies also during the year in any one locality, more particularly in seaside or holiday resorts.

In London, the term "dust" is generally used to cover ordinary ash-bin refuse, and "dustman" is synonymous with the provincial appellations, "ash-man," "scavenger," "corporation man," &c.

From a perusal of the analyses of this London "dust," one would not be tempted to use it in preference to coal for the purpose of raising steam.

On the contrary, one might suppose that it would be necessary to mix it with coal or coke to get it to burn at all. The following are typical analyses. The figures in the first column are given by Hutton for *average* ash-bin refuse; the second and third columns refer to London ash-bin refuse.

	Authority.		
	Average refuse. Hutton.	London refuse. Codrington.	London refuse. Russell.
Breeze and cinder	50·0	28·8	63·69 including ash.
Ash	12 0	52·6	—
Paper, straw, and fibrous material	—	—	7·5
Vegetable refuse	13·0	14·2	4·61
Coal	0·7	0·15	0·84
Coke	0·3	—	
Bones and offal	0·6	0·25	0·48
Rags	0·4	0·425	0·39
Dust and dirt	20·0	—	19·51
Bottles	1 0	—	0·96
Tins and iron	0·7	0·35	1·00
Other metals	0·2	0·025	
Crockery	0·6	2·9	0·55
Broken glass	0·5	0·3	0·47
Total ...	100·00	100·000	100·00

It will be seen that the figures of the different authorities are not very diverse concerning those items that possess a calorific value.

The calorific value, or heat units per lb. of combustible, when containing the average percentage of moisture, is given by Dawson as below :—

Coal	9,344
Coke	8,000
Bones and offal...	5,344
Breeze and cinder	4,000
Rags	3,334
Paper, straw, fibrous material and vegetable refuse	2,534

(To be continued.)

ELECTRICAL LEGISLATION AND THE INST. E. E.

(*Concluded from page* 879.)

In the statement by Alderman George Pearson, he starts with the assumption that the inquiry involves the question of curtailing, if not suppressing, municipal trading, and in this respect his instincts are no doubt correct. The whole question of the position of the industry is connected with the interference of the local authorities, and as the worthy alderman is the champion defender of what he considers as their special mission in monopolising the supply of gas, water, trams, and electric light, and keeping out those terrible, but, after all, somewhat useful members of the community called "capitalists," it is natural that he should enter the arena with all his quills erect, like an angry porcupine!

"In my opinion," he says, "cities do not exist for the purpose of providing remunerative investments for capitalists, but for the purpose of providing cheap, economical and efficient public services." Doubtless, when his Corporation wants to float a new loan, the capitalist will be in some request.

E

Alderman Pearson has too good an opinion of the Board of Trade to suppose that they would allow a council to obtain a provisional order and sit upon it, and yet the Bristol hen sat for 10 years upon the electric egg before it was hatched, and in no case has an order been revoked, as a matter of course, if no works have been commenced when the two years for supply of the compulsory area have expired. He blames the ratepayers for the delay, and thinks that they ought to be allowed to please themselves. Good reasoning, if they were appealed to, but Alderman Pearson must know that, as a rule, they are not consulted as to whether a provisional order shall be applied for, or if and when it shall be worked if obtained. It is true enough that ratepayers, from mere apathy and indifference, leave too much in the hands of their representatives, and hence it is that ruinous municipal trading has been undertaken against their own interests.

Alderman Pearson credits the Local Government Board with encouraging local authorities to acquire trading concerns such as gas, water, electricity and trams, but does any such policy exist in that department?

We doubt it, and are inclined to think that their action has followed a mere routine, not based upon any policy of assisting municipal trading; we know that in a recent case they refused to sanction a loan for electric lighting until the results of an election to the Council were known, recognising in that instance the principle of the ratepayers deciding the question, notwithstanding the opinion of a majority of their representatives.

It is the legislation that is in fault, and not the action of the departments engaged in giving effect to it. Parliament has decreed that the local authority shall have a preference, the Board of Trade act accordingly in granting orders, and the Local Government Board look into the question of ways and means for carrying them out, inclining to the position that the Board of Trade, and not themselves, are responsible if the powers are given without the consent of the ratepayers.

Alderman Pearson attacks the companies and all their deficiencies, but he should remember that they trade with their own money at their own risk, and they alone suffer if the speculation do not succeed if "they desire to thrust an electrical supply upon a town whether it desires it or not." His reason why England is behind America, viz., because the supply of current is so largely in the hands of public companies, which obtain such high prices for private lighting that there is no inducement to push for the supply of cheap current for public lighting, is startling in its inaccuracy.

As a matter of fact, companies are too anxious to obtain the public lighting as an advertisement, apart from its being a long-hour supply, and they invariably offer very cheap terms. If Alderman Pearson had inquired before launching his statement about the London street lighting, he would have found that the cheapest street lighting is furnished by companies, and the dearest by local authorities, to wit, the Westminster Company obtain 1·93*d.* per unit, the Metropolitan Company 1·96, and the Charing Cross Company 2·21, against 2·32 up to 2·97 by the six local authorities.

In dealing with the other notes for consideration of witnesses, Alderman Pearson trots out all the old and exploded fallacies; for example, large towns can do electric work cheaper than companies, and small towns can be grouped in County Council areas, but he sees no necessity for having one large area controlled by a company.

Under Note 3, he approves of cheap traction, and thinks penny fares too high, but believes that cheap traction will solve the question of overcrowding in towns; some enthusiastic municipalisers suggest running the trams for nothing, and reducing rates out of the profits, but Alderman Pearson has not quite reached this ideal. His opinion that companies cannot hope to obtain their capital on terms which can compete with the municipalities, depends upon how he makes his calculation. He considers that the sum necessary to pay interest and sinking fund and thus purchase the undertaking in 30 years, is less than the interest paid by a company upon debentures, preference, and ordinary shares. Of course he ignores the question of depreciation and renewal, although, if the life of the plant does not exceed the 30 years, either the consumers must provide sufficient profit to repay out of revenue within that time the whole of the capital expended upon it, or the undertaking will be represented by fresh loans.

Under Note 4, Alderman Pearson contends that present contracts should not be varied by fresh legislation, but that is no reason why future undertakings are not to be governed by more equitable and sounder conditions. He is thoroughgoing in his opposition to all change in the present condition of things, and evidently believes in the municipal being the "best of all possible worlds."

The cross-examination of the alderman was undertaken by Messrs. Siemens, Sparks, Swinton, Crompton, Madgen, and Langdon, and brought out many facts and opinions.

For example, the delay in working the Bristol provisional order was due, according to Alderman Pearson, to the "battle of the tensions," which was settled in 1887—8, when they adopted the "high" and went ahead, but under very easy steam, for it was not until August, 1893, that the city was lighted. The alderman has, no doubt, discovered that the victory in the battle of the tensions did not produce finality, and that his Corporation have already had to sink a considerable sum in adopting the new developments which naturally take place in such an industry, and render municipal trading in it so unsound a speculation on behalf of the ratepayers.

The alderman was not always consistent, nor can his views generally be ranked with the most enlightened opinions on the great problems which underlie the question of the best systems of generation, transmission and distribution of electricity, and its connection with industrial redistribution, and the relief of congestion in towns.

He apparently contracts all his ideas within the small area of Bristol. He might venture to purchase the trams and go five or six miles into the country, but his idea would be to bring an extra 10,000 people into Bristol every week, and he would not supply power outside until he had finished the inside supply.

With such limited ideas, it was not surprising to find that his vigorous attack upon the companies crumbled to pieces under the questions of Lieut.-Col. Crompton, and he tried to evade a direct reply to the pertinent question of whether his statements ought to go forth, by a *tu quoque* answer, "Shall I give you some of the statements that are made about us?" In fact, his answers to the searching questions of his interrogator were far from satisfactory, and disappointing from so outspoken a champion of municipal trading, but a man who accuses *companies generally* as being *impure* is evidently too much prejudiced to be taken seriously.

In one respect he voiced a very common view entertained by many town councillors, viz., that because the supply of gas, water and trams had been profitably developed by private enterprise, therefore the trade in electricity, although an entirely different undertaking, should be in the hands of the municipality.

Alderman Pearson is an advocate of the nationalisation of the railways, and the following answers to questions by Mr. Madgen are a fair sample of his reasoning; with this extract, the demands upon our space forbid our dwelling further upon the views of this interesting advocate of municipal trading.

Alluding to Alderman Pearson's views as to the Bristol tramways, with an extension of five or ten miles into the suburbs, he replied to Mr. Madgen that he did not think the public want it any further; and, in answer to the further question, "Do you think that such provision would do anything else than merely add to the attraction of that centre and increase rather than relieve the congestion?" the queries and answers proceeded as follows:—

A. No; at the present moment many of our manufacturers are taking places two or three miles out for the sake of getting cheap labour, building a factory requiring 500 girls, say, four miles from the centre of the city.

631.—*Q.* Quite so; but do you not think that if such factories could go 30 or 40 miles into the rural districts outside the city, and they could get cheap power and inter-urban tramways, they would be still better off?

A. First of all you must give them cheap power and cheap carriage. It is not a bit of good manufacturing an article 10 or 20 miles from where it is wanted. Given all the requirements you speak of, given the labour there, possibilities of living in a healthy state there, cheap traction out and cheap traction back to the port for the goods, it might be done, but you must always have regard to

the increase of the price of the article by every penny you put on it in the way of carriage.

632.—*Q.* Quite so; but for one moment do not you think that if facilities were given in the way of cheap power for industrial purposes, and improved traffic facilities by means of light railways for a distance of 30 miles from Bristol, it would be better that congestion should be cured that way rather than by trams in the immediate neighbourhood of the big city?

A. If you can comply with two other conditions, that is to say, cheap traction for the raw material into the district, and cheap transit for the manufactured article back again. But now I am asking you to do something almost impossible—to pay a long carriage on your raw material, and then on the manufactured article. That is a very severe tax.

633.—*Q.* I will put the question again. Providing that you can be given, or the manufacturer can be given, in the rural districts of the counties of Somerset and Gloucester, improved and cheap traffic facilities both for his raw material and his finished goods, and could be given cheap power for his factories, would it not be better in the interests of the community that he should settle in those rural districts rather than that he should come into the immediate neighbourhood of a big centre such as Bristol, where if you have not congestion to-day you have reason to apprehend it?

A. If you ask me the abstract question——

634.—*Q.* I put it to you in a definite form?

A. In a definite form, whether it is wise to spread the population, I should say certainly.

635.—*Q.* Then your answer to my question is, Yes, is it not?

A. If you can do all the things you say. My answer would be Yes, on the assumption that you can do all you promise, which I do not think you can.

636.—*Q.* If we acknowledge it is desirable that we should have industrial redistribution and that the factories should as far as possible be moved out into the rural districts, under what system would you propose to provide the tramways, the traffic facilities, and the cheap power?

A. That could only be done, as I have said, either by a national or some other system of light railways. The municipality in its limited sense would not be prepared to go out that far.

637.—*Q.* Are you aware that all previous experience in regard to national control of railways has been unsatisfactory from the economic point of view?

A. Yes, from an economic point of view. I believe complaints have been made that the Government does not do what is required by the manufacturers in going exactly where they want, and that kind of thing.

638.—*Q.* You are aware that while the Government railways of France show an annual deficit, the English railways show a good investment for the large sum which represents the savings of a vast mass of the population?

A. I was not aware of that fact, but I can very well believe it. Where the railways are in England you will find out the traffic is much heavier than on the Continental railways.

639.—*Q.* Are you aware that the Government control of railways in India has proved extremely unsatisfactory, and that they are reverting to——

A. I do not know anything about India.

We commend the report to our readers as a most interesting statement of the case for legislative reform; we have dealt with a few types of evidence only, but the whole of the 189 pages of the pamphlet circulated by the Institution will amply repay perusal. We await with interest the result of the coming interview with the President of the Board of Trade.

NOTES ON TWO ARTICLES OF SERVICE IN TRAMWAYS.

Is it possible for man to count the various rail bonds in existence? Good, bad and indifferent—of all there are many examples Under which head shall we place the "Perfection" bond, brought to our notice by an illustrated paragraph in the *Street Railway Review* for April?

As we have stated previously, the main things to be looked for in a perfect bond are, ease, cheapness and tenacity of attachment to rail; such good contact between the two surfaces that the current-carrying capacity will not be impaired, nor the possibility of electrolytic or chemical action permitted during the life of the rail. As in so many other things, the most perfect form is also the simplest form.

Some bonds which have had considerable sale in this country, chiefly because the buyers did not know what they wanted, are constructed to require the maximum amount of labour with a minimum of efficiency under the test of time. With one or two prominent exceptions contact between rail and bond is made by driving a taper drift-pin into the hollow terminal, resulting in the copper being swelled out in all directions and completely filling the hole, unless that has been drilled much too large. With the best of this class of bond it is necessary to remove the paving or ballast on one side of the rail only. This point is material only in replacement work, but is of no little importance. The bond under notice makes contact by the same pressure applied from the inside of its terminals, but the novelty—if novelty there is—lies in the expanding plug being part of the terminal itself. Hardened bronze, conically-shaped plugs are cast in at each flat end of each terminal. The terminal being inserted into the rail web, a suitable compressor presses the two plugs nearer together, thus expanding the terminal and filling the hole. The plug in the free end of the terminal is flanged out, so that when pressure is exerted the head of the terminal tends to be flattened out or rivetted over on the surface of the rail web. It is stated that a movement of the plugs closer to each other by $\frac{1}{4}$ in. expands the terminal by $\frac{3}{16}$ in., a rivet head of $\frac{1}{8}$ in. being formed at the same time. This rivetting over looks very pretty in the block, and may help to make the bond rigid in the hole, but it cannot be taken seriously as increasing the effective contact.

After careful consideration of the claims made for this bond with relation to its actual construction, we are inclined to think that it need not be labelled either good, bad, or indifferent, but superfluous. Indeed, after seeing almost the identical bond advertised on p. 126 of the same number by the G.E. Co. (U.S.A.) and carrying two patent dates with it, it may be that the term "superfluous" hardly fills the bill. Anyhow, whichever of these bonds was first in the field, it appears to us that all that is claimed for either might have been done equally well by a bond having suitable conical cavities left in the terminals to be filled by corresponding projections on the jaws of the compressor. There is no virtue in the bronze plugs after they have been once compressed, so that their weight and cost might be saved.

On the same page of the *Review* is illustrated and briefly described the "Ham" trolley-catcher, which seems to be somewhat of an improvement on the only other one we know. The trolley catcher, in any shape, is at present almost unknown outside America, perhaps for the reason that the speeds are so much less, perhaps, too, because American overhead construction has been in the past not so well aligned as on this side. Nevertheless, it is an admirable device, and one which, if generally adopted, would save considerable worry and expense in the item of guard-wire repairs in particular, and overhead construction repairs in general. The trolley rope is wound round a drum, to which is connected a pawl which is inoperative while the rope follows the trolley wheel as the height of the trolley wire varies; in other words, while the rope moves steadily and comparatively slowly. Directly the wheel leaves the wire, and, in so doing, pulls the rope upwards with a violent jerk, the pawl flies out to engage with the teeth of a fixed ratchet. From 2 in. to 4 in. is the distance which the wheel jumps before being arrested.

It is not advisable to put these devices on short cars running on bad track, as the jerky oscillations of the car are liable to actuate the catcher when not required. Trouble has been experienced also on a road where the guards were too lazy to change the catcher to the other end of the car for the return journey. All kinds of excuses were made, and considerable malicious damage was actually done to the catchers, in order to evade this duty. In this case the management was deplorably invertebrate, and it would not be difficult on most roads to discourage such conduct.

The catcher is especially useful where there are many overhead switches, &c., as it renders unnecessary the continual presence of the conductor on the rear platform. It is useful also on long cars wearing two trolleys, as time is not wasted at termini in untying the rear trolley rope and tying down the front one. Here, of course, it would be necessary to fit two catchers per car.

Unfortunately, it is not possible to use these catchers on a side trolley system, where they are needed more than anywhere else, because, as a rule, the trolley rope cannot be allowed to depend freely from the trolley-head, on account of the danger to the drivers of passing vehicles and the possibility of entanglement with other cars.

THE HOME ENVIRONMENT OF BRITISH WORKING MEN.

In discussing this question in the *Engineering Magazine*, Mr. Percy Longmuir does not altogether approve of the many adverse criticisms of the trades unions that are now so frequently made. He asks if other than a policy of restriction of output may not be at work in Great Britain to limit progress. We suppose Mr. John Burns would say that the drink habit had as much to do with it as anything, and we are certainly in agreement with this.

The author asks if there is not room for improvement in British commercial methods and in the education of employer, workman and merchant. Perhaps there is, but it is quite possible that the grumble has been overdone, though we believe that stagnation often creeps down from the head of a concern who has been born heir to the business, and has never gone through the A B C of his business, or acquired the knowledge to fit him to occupy his position. The author, while suggesting these causes, confines himself rather to the social conditions of the workers, and refers to bad physical results which follow on overcrowding in dirty slums. This degeneration is, we think, more visible in London than outside. Overcrowding is due to lack of railways. There are not sufficient means of communication to enable workmen to travel to and from their work in a place like London. Much good has already come from the removal of many engineering shops to places like Walton, Bedford, Luton, and Dunstable. In those small towns the workman is really in the country, and ought to be able to get decent home accommodation. But the south country workman is naturally untidy as compared with his brother further north. Compare, for example, the backs of the houses by which the South-Eastern Railway passes in the direction of Lewisham. The agglomeration of rubbish in what might be a decent back garden is disgraceful.

One may travel over working class streets all the 40 miles from Manchester to Leeds, and there is tidiness all the way and no waste paper in the streets, showing that municipal affairs are better conducted than by the London authorities.

Mr. Longmuir thinks the working man is practically damned from the cradle, with a moral training in the streets, football, as a looker on, for play, poor theatres for amusement, a sporting paper for his reading, a juvenile "'Arriet" for his wife, and a swarm for his family, who go through the same process. As regards evening study, as to which the author speaks, this is almost useless for a boy in a London workshop. Students at evening classes do, no doubt, usually come from the lighter trades. How can a youth from a dirty workshop get home to clean himself and get back to the city to evening classes? There are thousands of workmen who are in receipt of sufficiently good wages to enable them to give their sons much better education than they now give them. Some would do so if the institutes were open in the day time. Undoubtedly, the trouble is that men spend their money principally on sport and drink. How far the discomforts of a compulsory home in a city slum are to blame, it is beyond us to know.

Doubtless, it does require a strong will to rise superior to such surroundings, but there are those who do so, as anyone can see in the too occasional exception to the prevailing untidiness in a street. As a rule, we believe the tidy house is usually run by the less physically strong of the weaker sex, while the large and brawny ones gossip with folded arms at their doors. The wife of the working man is usually lazy and untidy and full of venom against the better half of the poor clerk, who aims higher on much less income.

The author is somewhat inaccurate, and talks loosely in places. Thus he says that the adoption of the metric system would save two years in every child's school life.

As regards workshop conditions, we think employers might do something to render their places decent. Many of our readers have seen something of what has been done in some of the German workshops in the way of cleanliness and sanitation. Yet in some of the largest and newest English shops there are practically neither warming nor washing facilities for the men, nor even a place where to hang their clothes out of the shop dirt.

We think that American and German workshops are overheated, but then, no American is ever happy under 70° F. We doubt if anything over 60° F. is necessary even for a sedentary occupation, while probably 55° is enough where men are moving about. Undoubtedly it pays to warm a shop, especially in cities where house accommodation is limited, as in London, or, perhaps worse, New York; and men should not need to wash off the work stains at home.

The question of workshops generally is treated in the same journal by Mr. T. S. Bentley, who combats the erroneous idea that shop warming is out of place in a piecework shop. The use of dark buildings is another evil. A workshop should be suited to its work. As regards machinery, it should be treated like military machinery, which is never expected to be worn out, but is always supposed to be kept up to date and scrapped when obsolete. Within reason, this is a good point to bear in mind. Theoretically, we all believe in specialised machinery, but in practice limitations step in, because a special machine can only do a narrow range of work, and hence follows the good rule of not setting out to do too much, but confining effort along a narrow groove, like one American firm said to make one machine only, and only one size of that one machine. It cannot cost that firm much to keep its patterns up to date, and it can, therefore, sell the latest type of machine, and probably do business where the maker of more machines less up to date would find it difficult.

Finally, we are told not to be too careful in buying raw material, but to get that which will machine most easily. This, of course, is what is carried out in America to an extent that has become a fault. There everything is apt to give way to ease of manufacture. A word of warning may not be thrown away in this direction. Material ought to be chosen for its suitability for the work it has to do. The wearing quality being right, then by all means select what will finish at least cost for labour, use of tools, &c., and prime cost.

Lastly, never hint to an American that American cast-iron is unduly soft. It makes him angry, or, as he says, mad, and he is liable to lapse into blasphemy.

DIFFICULTIES IN MACHINE STOKING.

There are far more difficulties in the way of successful mechanical stoking than at first sight appear. To begin with, in the system of sprinkling the fresh fuel over the whole surface of the fire, there is considerable trouble in the production of smoke, which though not dense, is very apt to be persistent. Then when the fuel is dusty, the dust is carried out of the furnace by the winnowing action of the draught, and deposited in the flues, or even carried out at the chimney top. It is also not easy to sprinkle fuel evenly over the grate surface, and where the fire burns thin, it is apt to burn faster, and steady working becomes difficult. There must be fairly frequent levelling up by hand.

Where coking systems are employed with moving grates, it is very usual practice to allow the grate to be made far too long, and to allow the fuel to burn completely away during the time it is travelling to the back of the grate. Nothing remains to fall over the end of the grate, but clinker. Consequently, the back end of the grate is nearly bare of combustible, and a very great volume of air is admitted, to the great detriment of the fire, and the reduction of efficiency of heat transfer. Some recent correspondence in regard to a travelling chain grate showed up this point very clearly. The fuel is burned to ash long before the grate has carried it to the dumping plate at the back end, and at half load the results are poor. It is possible that better results might be obtained if it could be arranged that little or no air could get through the back end of the grate.

In some moving grates the grate is kept very short, and dumps the fuel behind the bridge before it is completely burned. No excess of air gets through the grates. The coal gives off its gases as it travels, and the remaining combustible tumbles over into the ashpit and then burns, because air is admitted through the mass of it, the bridge being open below the grate for this purpose. Really, the grate surface is not so small as it appears. The opening under the bridge legitimately counts as grate area, in which the bars are absent, though their effect is perhaps taken by the clinker mixed with the burning mass. By suitably arranging the thickness of the fire, the air supply can be made to secure the best results in carbon dioxide, which, after all, is the real crux of performance of a furnace, for there can be no two opinions that if the furnace gases contain a large percentage of dioxide, no monoxide, and no smoke is made, then that furnace must be efficient. The results of such efficiency are too often spoiled by the enormous leakage into the flues of air, which acts simply as a diluent of temperature.

This air leakage goes on not merely through bad mortar joints, but through the pores of the bricks themselves. Water-tube boilers, which must be grouped at most in pairs, offer a very large surface for leakage, and ought to be protected either by sheet iron, or by paint or tar, or, where the money is available, by glazed brick. Blue brick is less porous than ordinary red bricks, and might advantageously be employed where economy is essential. Most of the smoke-prevention devices aim at admitting air to burn the hydro-carbons.

It seems frequently to be possible to make them succeed by carrying out the air admission principle too thoroughly. The sudden outburst of hydrocarbons where coal is hand-fired tends to this extravagance of air, not merely when firing, but long after the air openings should be closed again. Stokers cannot be got to attend to such matters, but where there is a large battery of boilers it might be possible to have a boiler house foreman responsible for the proper use of such appliances.

Users of mechanical stokers are often apt to be unreasonable in their demands. The mechanical difficulties of a stoking machine are very great. The conditions under which the machine is employed are onerous, not to say bad. Yet the machines are expected to run with a fraction of the care and attention bestowed on a steam engine working in clean surroundings.

Mechanical stoking begins with one great advantage, uniformity in action and continuity. Hand-firing is bad in principle, for it can only be carried out by opening the fire door and admitting an enormous excess of air at the time. If the dampers are then closed there is the disadvantage that the fuel on the bars ceases to maintain its temperature, and there is a distinct slackening off in the performance. A really good fireman counteracts these disadvantages more or less by his intelligence and skill, while a machine that is not in perfect order loses some of the advantages which it possesses from its continuous action.

For horizontal moving grates we cannot see that mechanical stoking can be economically carried out unless the system is adopted of burning off much of the fuel in a mass behind the bridge, cleaning out the clinker and refuse from time to time as it accumulates on the ash pit bottom.

LEGAL.

The Purchase of the Metropolitan Electric Supply Company's Undertaking.

For some time past a tribunal consisting of Mr. C. A. Russell, K.C. (umpire), and Mr. Robert Vigers and Mr. W. C. Ryde (arbitrators), has been inquiring into the circumstances connected with the purchase as a going concern of the Metropolitan Electric Supply Company's undertaking in Marylebone by the Borough Council of Marylebone. The sum claimed by the company is £2,771,708. Mr. Balfour Browne, K.C., Mr. C. A. Cripps, K.C., Mr. E. Moon, K.C., Mr. Sargent and Mr. A. T. Lawrence represent the company, while the Borough Council is represented by Sir E. Clarke, K.C., Mr. Fletcher Moulton, K.C., Lord Robert Cecil, K.C., and Mr. A. B. Cave.

Mr. Balfour Browne opened the case for the company, and said the parish of St. Marylebone was included in the company's West London Order, confirmed by an Act of Parliament in 1889. Current was supplied to that area by the company's generating stations at Rathbone Place and Manchester Square. Those generating stations also received current from the company's main station at Willesden, as did also certain sub-stations situated in the Marylebone area. The supply of current to the Marylebone area commenced on September 27th, 1889, current being distributed at a pressure of 1,000 volts, reduced by house transformers to about 100 volts. There were some exceptions, but that was the general practice. Later in 1897 the supply was altered to continuous current by means of a system of low pressure networks suitable for either alternating or continuous current. In 1900 a large scheme was adopted for supplying continuous current in place of high pressure alternating current in the greater portion of the Marylebone area. The Manchester Square station had a capacity of 2,100 KW. of continuous current generators, and was provided with 12 water-tube boilers. The Rathbone Place station was equipped with plant of a capacity of 825 KW. of continuous current generators, and had five water-tube boilers. The sub-station at South Street, Manchester Square, had 3,600 KW. of transformers for dealing with current supplied from Willesden, and had a 100-KW. motor-generator. The sub-station at North Street, Manchester Square, had 3,210 KW. of motor-generators for converting high pressure alternating current from Willesden into continuous current. The Rathbone Place station had also 1,500 KW. of transformers for dealing with Willesden current, and 420 KW. of motor-generators for converting Willesden high pressure alternating current into continuous current. Marylebone Passage station had 690 KW. of transformers for reducing the voltage of alternating current from 1,000 to 200 volts. All the generating stations and sub-stations were leasehold property, expiring variously in 1913, 1930, 1961 and 1968. Other properties that the company had acquired in Marylebone in consequence of complaints of vibration and noise adjoining the stations and sub-stations expired variously in 1913, 1941 and 1972. It was found early in the company's history that much benefit would result both to the company and its customers if all the areas could be worked together as one system, and trunk mains were accordingly laid between all the four generating stations (North Street, Rathbone Place, Manchester Square and Amberley Road), and current had, for a number of years past, been distributed as required from any one station to supplement the resources of the others. Board of Trade sanction to that method of working was obtained in June, 1896. In addition to the stations and sub-stations previously mentioned, a narrow strip of Marylebone was supplied with current from the Norfolk Crescent Mews sub-station. Arrangements had been made for the severance of the Marylebone portion of the distributing mains from the Paddington portion when the Marylebone Borough Council took over the company's Marylebone undertaking. The expense of that physical severance, and also the injury that would be done to the remaining portion of the company's undertaking by losing that alternative source of supply would have to be considered in the inquiry. In the same way, the Rathbone Place station had, for some years, supplied part of the company's mid-London area, and arrangements were being made for the complete severance of this area from Marylebone before the Borough Council entered into possession, thereby setting free the whole of the plant in the Rathbone Place station for the supply of Marylebone alone. The Electric Lighting Order Confirmation Act, No. 1, Section 2, provided that the Metropolitan Company should sell, and the Marylebone Borough Council should purchase, the St. Marylebone undertaking and business of the company as therein defined, except the offices at Stratford Place, which the company were to occupy and make no claim, the terms being "for such purchase money and compensation being a sum in gross and on such terms and conditions as may be agreed upon between the company and the Borough Council, or, failing such agreement, as shall be determined by arbitration in manner provided by the Lands Clauses Act." He agreed with Sir Edward Clarke that the whole scope of the section of the Electric Lighting Order Confirmation Act, No. 1, was to make that a purchase under the Lands Clauses Act. The Electric Lighting Order Confirmation Act, No. 1, under which the purchase was to be effected, provided that the notice to treat for such purchase should be given by the Borough Council to the company within six months after the passing of the Act, unless that period was extended with the consent of the company under seal. The date of transfer, he took it, meant when the Council paid the money. The company were quite prepared to transfer the whole Marylebone undertaking and business to them when the sum to be paid had been awarded, and when such sum had been paid. There was, of course, no completion until the Council had the works and the company had the money. The company's claim was therefore first:—Compensation for the actual loss which they sustained by having their Marylebone undertaking and business taken from them compulsorily; and what they lost was not merely the very large income they were making that day, but the chance of increasing that income in the future—which was not only chance, as would be shown, but a certainty. The award must therefore include compensation for the loss of future profit on their undertaking and business. At the same time, the future profits must be limited to a period of 30 years, because under Sec. 2 of the Electric Lighting Act, 1888, they had only 42 years to run, at the end of which period they were bound to sell to the local authority. Therefore the first claim was the value that day of future profits for a period of 30 years, and also under the Land Clauses Act, compensation for the loss which the company would sustain by having the important Marylebone portion of their business severed from the rest of their undertaking. Further than that, they had to look at the Act of 1888 and a second item of claim came under Sec. 2 of that Act. He had limited the claim for profits to 30 years, but at the end of 30 years the company had still the right to sell under that section, and they were parting with that right now. The section provided that "on receipt in writing from the local authority of notice to purchase, the undertakers shall thereupon sell their undertaking upon terms of payment of the then value of all lands, buildings, works, materials and plant of such undertakers suitable to and used by them for the purposes of their undertaking, such value to be, in case of difference, determined by arbitration, provided that the value of such lands, buildings, works, materials and plant, shall be deemed to be their fair market value at the time of the purchase, due regard being had to the nature and condition of such buildings, works, materials and plant, and to the state of repair thereof, and to the circumstance that they are in such a position as to be ready for immediate working, and to the suitability of the same to the purposes of the undertaking, and where a part only of the undertaking was purchased, to any loss occasioned by severance; but without any addition in respect of compulsory purchase or of goodwill, or of any profit which might or might have been, or be made from the undertaking, or of any similar considerations." They regarded the clause relating to the state of repair of the buildings, works, materials and plant, as not unimportant from their point of view. Therefore, at the end of 30 years they were to be paid the then value, and not merely the value, but something was to be given them because they were all ready to work. If the company merely handed over the money value of those works to the Council at the end of 30 years, that would have been one thing, but it would have taken them two or three years to erect their buildings, and they were going to hand over the whole of the buildings and plant ready for working, and that must be considered to their credit, because the direction in the section was, "and to the circumstances that they are in such a position as to be ready for immediate working." That was a matter which they wished to specially bring forward. It would be seen that although "the then value of lands, buildings, materials and plant" were the same words as in Sec. 43 of the Tramways Act, that reference to the circumstance that they were ready for immediate working was in addition to the Tramways Act, and was a new element introduced for the benefit of the electric lighting company. The said head would be the value of the lands, buildings, works, materials and plant at the end of 30 years, discounted, of course, to present value, because they were going to be paid shortly, and that had to be arrived at on totally different principles from the first head of their claim, which was the present value and future profits of their undertaking, plus an allowance for severance. On that head, therefore, of their claim there would have to be considered, first, the extent and growth of the company's business in the past, and from those they would have to come to some conclusion as to its probable growth in the future. He did not take it that that meant the actual value of the company to-day, which could easily be measured. They were making in that district of Marylebone so much income that day. It would be easy to turn that into a capital sum on the supposition that they got it—that it was absolutely secured, and they should go on making it for the next 30 years. But it was found that their income was going up by leaps and bounds, and those figures would be spoken of by the first witness to be examined. The difficulty then arose as to how much they should probably be making during the next 30 years, and details as to that had been got out with some minuteness, but at the same time with very great caution, so as not to assume that the profits would go on in the same ratio but in a diminishing ratio, and in that connection certain considerations would be put before them. He wished first of all to say that they were absolutely safe, for they had practically a monopoly of the district. The Vestry of Marylebone in 1898 attempted to get power to compete with them, and that was fought out in Parliament at very great length, and the Bill was rejected. He did not know a case in England that day where a local authority had been allowed to compete with a company. There were companies competing with companies, as could be shown in a district in London, but no case where the local authority had been allowed to compete. Only the other day, before the Board of Trade, the Borough of Camberwell, having purchased the plant of the London Electric Supply Corporation in the northern portion of its district, asked leave to compete with the County of London and Brush Provincial Company in the lower half. There was, and had been, arranged a purchase clause in the company's order, and the purchase clause was that they might purchase at any time on giving £133 for £100 of the company's capital. They did not like those terms, and said they wanted to compete. But the Board of Trade said they would not allow them to have their order at all till they had purchased the company. Therefore, so far as competition with a local

authority was concerned, he thought they were absolutely safe. What had taken place the other day made them safer still. The L.C.C. promoted a Bill, by which they sought to get two powers, which might have affected that company; one being that if at the end of 42 years the local authority did not purchase, the L.C.C. might, and his company had insisted on speaking for the electric companies of London, that that was not fair. They had got the chance of one purchaser, but not of two, which made it more certain that they would be purchased. With one local authority they might say they did not want to purchase, and they would then have another lease of 10 years. That demand of the Council was rejected. The other power which might have affected the company materially, not in Marylebone, but in some other districts, was that the L.C.C. asked for leave to purchase by agreement any company, and what they feared, and what other companies feared, was that they might either set up a company or buy some company that was doing very little, and compete. The proposal was rejected, and, in fact, the whole of the L.C.C. Bill for electricity this session had been rejected. He was, therefore, certain that so far as local authorities were concerned they were safe from competition. With regard to competition from companies, they were in that district practically immune, because various attempts had been made. In 1898 the County of London and Brush Provincial Company, which did not like to be competed with in Camberwell, wanted to compete there, and applied for an order, as did also the Marylebone Electric Supply Company, but neither of the orders was granted by the Board of Trade, on the opposition of his clients. In 1899 the Marylebone Electric Supply Company again gave notice of intention to apply for an order, but they abandoned any proceedings. In 1900 the Marylebone Electric Supply Company again applied for and obtained from the Board of Trade an order for competitive powers in Marylebone. A Bill was introduced into the House, and was thrown out on second reading; and in 1901 the Marylebone Electric Supply Company applied and obtained a provisional order from the Board of Trade, and that was withdrawn by the promoters on the assurance by the Borough Council that they would insert certain clauses in the order which they were then promoting, which was the order subsequently confirmed, and which was before them now. Therefore, he thought there was no competition possible, all those failures being registered in the past. It would be a very bold company, he thought, that would try and put its foot in Marylebone. There was an agreement between them and the Vestry in 1889 under which certain friction took place between them, and they had to apply for an injunction against the Vestry. An arrangement, however, was come to, and he only mentioned it because it got rid of all difficulties that might possibly be raised. That agreement had these two clauses which were important. In consideration of the company withdrawing their opposition to the present Bill, the Council agreed to withdraw their opposition to the company's Bill, and Clause 3 was that on the completion of the agreement between the Council and the company, and the confirmation of the order by Parliament, all questions on the subject of the present litigation were to be treated as if both parties were perfectly satisfied. So that that gave them a clear sheet for the past; there was no going back on questions that were in dispute, and there was only one thing he would mention out of that clause. The Borough Council were to purchase from the company in bulk all electrical energy they might require beyond the amount which they could from time to time generate themselves either within or without the St. Marylebone area, the company to supply on such conditions as to notice and otherwise, and at such reasonable prices as might be agreed upon; those points in case of difference to be settled by an arbitrator to be appointed by the Board of Trade. Of course, as yet there was no arrangement as to the bulk supply, and until they knew what they were going to take—they might take one unit, and no more—they could not form a basis of what they were going to get from them. Therefore all their calculations assumed that they lost Marylebone, and that, in losing Marylebone, they lost the possibility of utilising plant which they set up for the purpose of supplying Marylebone. The tables they put in showed the absolutely continuous growth in their hands of the business in Marylebone, and also that their immense income in that area was derived from a comparatively small portion of the inhabited houses. Moreover, a large portion of the houses connected in 1901 were only partially supplied. They found that very many of the people had put in a small amount of electric installation, apparently for experimental purposes, and when a person was only in for a year or two at the end of a lease, they were content to go on with that small amount of installation, but when it changed hands, and the landlord had to try and get another tenant, they knew he installed electricity throughout. Their growth had been continuous, and they were deriving it from a small portion of the number of houses in Marylebone, and when they had got customers, they were not fully taking the electric light. All that pointed to a very large growth in the future. Then the company had a great future before them as to motive power, heating and other purposes, only very slightly developed indeed at the present time. The annual increase in the number of consumers showed no signs of diminution; the amount of current sold per consumer was steadily increasing, the amount consumed per lamp was steadily increasing, the use of electricity for motive power, heating and other purposes than lighting was only in its infancy, and a great number of changes were taking place in Marylebone which would necessarily lead to a much greater use of electricity, and the development of nearly one-half of the habitable area of Marylebone as a source of demand for electricity had hardly yet begun. Then in a recent case (Freake *v.* Kinnaird), Mr. Justice Joyce held that the provision of an electric lighting installation exclusive of fittings such as would ordinarily be supplied by a tenant was an addition within the meaning of Sec. 13, Sub-Sec. 11, of the Settled Land Act, 1890, and might be properly paid for out of capital money, and that showed considerable development in the direction of electrical installation. Again, a large number of house agents who would be called would say that they could not let houses now unless they were wired for the electric light. As to the working expenses and the maintenance which must be set against the future profits, coal had been very high in price, as they knew, and the company had passed through bad times, but certain economies were being introduced which, with a diminution in the price of coal, would greatly tend to increase their profits. They had erected water softening plant at several of their stations, the extension of the continuous current system would mean a very great saving, and house transformers could be done away with, which caused an enormous waste of electricity. As to additional capital required, that also had been carefully calculated, because they did not think they could go on supplying that district with its enormous increase until 1931 without additional capital. Then as to severance. First, there was the physical severance, that would be dealt with by their engineers at considerable length. They had to sever the Mid-London portion of Rathbone Place network and the Marylebone portion of the Norfolk Crescent Mews network, and the St. John's Wood district from Amberley Road circuits and connect it with Manchester Square, and reconnect the 10,000-volt trunk mains between Amberley Road and Norfolk Crescent Mews, now traversing part of Marylebone. There was also a serious matter for further consideration, which was the increased cost of working which would be entailed by reason of that severance. In conclusion, he would say that he had assumed against himself that the local authority would purchase at the end of 30 years, because it was quite possible at the end of 30 years they might not be purchasers, and then he would have profit for the other ten years. Barring the one question which was very important, the valuation to them of having the plant ready for working, the case seemed to him a very simple one indeed, and such as they dealt with every day. The value was the value to them of those works in Marylebone. The value to them was not what they had made out of them—they had that and spent it—but the value they could make out of it in the future. They were also to be compensated for any loss or damage by reason of cutting it in two, which would entail considerable loss. They had fires in some of their stations; the Sardinia Street station was burnt down and they had the others to fall back upon; but when that purchase was settled they would have no such possibility within their own works, and that insurance went. Therefore the present value and future profit and severance was the first head of the claim. Secondly, what was the value of the works that they would have on their hands at the end of 1931, that value enhanced by the consideration that it was ready as a going concern to turn the wheel and supply electric energy?

Mr. John Conacher, the general manager of the Metropolitan Electric Supply Company, put in a number of maps showing the different areas supplied by the Metropolitan Company, and also the different parts of the Marylebone area. The company, he said, had erected large generating works at Willesden, which were opened in 1899, and from Willesden they transmitted the two-phase alternating current to sub-stations in London, partly along the towing path of the canal and partly along the streets. Witness went into a large number of details, showing the various mains of the company. There were two sub-stations in the Marylebone district; one was at the Manchester Square generating station, and that station, in addition to generating current, had the necessary apparatus for receiving current from Willesden. The Rathbone Place station was a station of a similar character. The third station in Marylebone was at Marylebone Passage, and was subsidiary to the Rathbone Place station, but had been a grave source of loss to the company. The original supply throughout the whole of the company's area, excluding the supply from Whitehall station, was entirely alternating high tension supply. The company adopted that system under the very best advice, because they were about to supply areas of a very wide spread character. Having established that system, they carried it on until the various districts of the company became ripe for changing to the continuous current system. They found the original system led to an enormous loss of energy, and early in 1897, they began to change the system in mid-London; practically the whole of that district now was supplied by the continuous current, and the plant at Sardinia Street station had been altered to supply continuous current. In 1898 the next step was taken by changing the system in the Rathbone Place area. Then the sub station was established at Marylebone Passage, and fitted with transformers, by means of which transforming was done in bulk. The result of that was to very much reduce the waste in transformers, and it entailed the laying in that area of low tension distributing mains, which were equally suitable for the continuous current if, in future years, that was adopted for the district. In the last two years the work of changing the district to the continuous current had been steadily carried on, and they hoped to have the whole thing in a state of completion before the end of this year, so that consumers could begin to change over from the house-transformer system to the continuous-current system. The whole scheme would cost £140,000 by the time it was finished. There was still a small portion of the Marylebone area that was being supplied on the old house-transformer system, but the company were making arrangements with a view to its being altered. Witness next proceeded to give details as to the value of the property and leases held by the company, and as to the expiration of the leases. With regard to the company's business, in 1891 the gross revenue was £12,120, and in 1901 it was £100,833, so that it had increased eight times in the 10 years. In 1891 the number of consumers were 354, and in 1901 they were 4,194. Already during that year they had added 218 consumers, which

indicated a much larger growth in the immediate future than there had ever been in the past. There had also been a tendency for the number of units sold per consumer to increase, as well as the number of lamps per consumer. According to the last census, the number of inhabited houses in Marylebone was 13,536, of which 3,108 were wholly or partially supplied with electricity by the company. There were still some large business premises in Oxford Street which were not supplied with electricity or were only partially supplied. They also looked to a very great development in the supply of electricity to the St. John's Wood area. They thought that as London grew, the land would be utilised more and more for house property, and those houses would be a big source of revenue in future years. Their concession went on to 1931.

Mr. CRIPPS: Do you think that during the whole of that period, having regard to the considerations to which you have referred and the tables you have put in, you have a safe field or market for a continuous increase of your business?—We think so, there is a very large field only beginning to be developed.

Whatever other conditions you have to consider, you have during the term of your concession, in your view, a practically unlimited market?—Yes; there are three main causes at work. The growing standard of lighting, to which it is difficult to assign a limit; I do not think the succeeding generation will be more satisfied with what is supplied them than we are satisfied with what went before, and this will involve the company keeping up that standard. There is an increased demand at stations, which will increase the payment for houses, and will lead to houses being built of a loftier character, and to the basements being utilised to a greater extent than was possible when gas was the only illuminant, and the increase of houses and the increased dimensions will undoubtedly tend to bring customers to the company.

Continuing, WITNESS said that last year only 78,000 units were sold for motors and heating purposes. So far they had discouraged people anxious to use electricity for motive power, having recommended them to wait until the change to continuous current had been made; it was largely to meet motor demands that they got rid of the alternating system, and as soon as the change was completed, no doubt they could push the motor and heating business very much more than was possible under the old conditions.

Do you think you have a large field for motor and other purposes outside lighting?—That is a class of business entirely in its infancy, and we believe from the increase which has taken place in the use of small motors for various purposes, that there will be a large field in Marylebone in future years from that source of business.

Mr. J. G. HEAD, senior partner of Geo. Head & Co., surveyors, house agents, &c., stated that he had been acquainted with the conditions of house property in Marylebone for 26 years. He had been particularly asked to consider the future development in Marylebone as regards buildings and so on, in connection with electric lighting, and he knew there was a growing tendency to wire houses for electric lighting. He frequently found now that the installation of the electric light was made a condition for the renewal of the leases.

Mr. E. W. RUSHWORTH gave similar evidence, and said he found that houses of a much smaller character were now taking electric light than formerly was the case.

Mr. S. CLARKE, surveyor, gave evidence, bearing on the estimates put in of the value of the company's property.

Mr. C. W. MILLER, surveyor, auctioneer and house agent, agreed that there was likely to be a growing demand for the electric light in St. John's Wood district, with which he was very well acquainted.

Mr. F. J. WALKER, general manager and secretary of the St. James's and Pall Mall Electric Lighting Company, said he had turned his attention especially to the prospects of the company's future increase during the next 30 years. He gave the figures of the increase in his own company's business, which had 486,000 lamps only. He found in the St. James's district that when houses had once taken the light, there was a growing tendency to increase its use. There was the tendency in regard to the electric light to have it for ornamental purposes, and that sort of thing. If a person had a particularly nice bronze, or anything of that kind, he put an electric light in it.

Mr. CRIPPS: I want you to apply the experience you have gained under the St. James's and Pall Mall conditions. What do you say as regards the future of Marylebone? We have it at present that 23 per cent. of the houses only are supplied, and that it is a district in the hands of one company. What do you say as regards the future?—I think it is a very low estimate to put it at; that 23 per cent. can be very easily quadrupled in the next 30 years.

Continuing, WITNESS said that although they had got 45 per cent. of the houses of St. James's, their engineer anticipated getting something like 500,000 more lamps in the next ten years. That was practically double their present connection.

Mr. L. H. HORDERN, manager of the Westminster Electric Supply Corporation, gave particulars of the progress of his own company. He considered that to a certain extent Marylebone was almost a virgin field for electrical enterprise, especially for motors.

What is your experience as regards the supply in the future of motive power from these electrical companies?—At the end of last year the equivalent in 8 C.P. connected was only 26,785, but this year there will be an increase of at least 50 per cent. in the last four months. There will be an increase at least of 40,000 equivalent 8 C.P. in motive power at the end of the year.

Continuing, WITNESS said that electrical lifts were increasing very much, and in many places the people were taking out hydraulic lifts and putting in electric. There was also a great demand just commencing for motor cars. They had one company in their district just started who expected to supply 800 carriages, and those carriages, if they did so, would use 2½ million units a year. Last year their motors used 350,000 units, and this year they would use about 600,000 units; he should think in another three years' time there would be probably 3 million units sold for motors. He should think Marylebone would be as good a field as Westminster for the motive power taken, if not better, for there was more vacant land there, and there would be much more chance of factories and such buildings being put up in such a district.

Mr. J. CONACHER was then re-called and cross-examined at great length by Mr. FLETCHER MOULTON.

On Monday the proceedings were resumed at the Surveyors' Institute, when the cross-examination of Mr. Conacher was continued. Some discussion took place between counsel as to whether the Metropolitan Company should be compelled to give information as to its special contracts with consumers in its different areas.

Mr. CRIPPS, K.C., said that the company did not object to giving information with regard to Marylebone, but he did not think they were called upon to give it with regard to the Holborn or mid-London area.

Mr. FLETCHER MOULTON argued that by the Electric Lighting Act of 1882, Sec. 20, the question of special contract was one which affected the whole area of a company's supply. By Sec. 8 of the company's contract with the Vestry the price to be charged for electricity to be supplied to ordinary consumers and the Vestry was to be regulated in accordance with the West London order. "But," the section went on, "the scale of prices charged in the parish shall not exceed the scale for the time being in force in any other parish or district in which the undertakers are authorised to supply energy under any provisional order or Act passed in the present session." That, continued Mr. Moulton, included mid-London, and it included St. Martin's, and therefore the company were saddled with that obligation—that they could not charge higher in Marylebone than in mid-London. If a person undertook to take 10,000 units a year, and the person who did that in mid-London got a special price, that special price just as much applied to Marylebone as it did to mid-London. He claimed he was entitled to examine the mid-London prices for two reasons. First of all, because he wanted to see what the prices had been there. It was very possible the prices in Marylebone did not accord with those in mid-London, and the profits they claimed were profits they could not make under the order; but still more important was it for the future, because the prices in mid-London were prices, of course, in the presence of competition. He wanted to see what competition had brought the price to there, because then he could see what even the existing competition would make prices in the future. It was quite clear that that clause linked together the two areas on the principle that they could not have a higher price in one than in the other, and therefore he contended that he was entitled to find out what the price of the other was.

Mr. CRIPPS said the point was an extremely important one. He submitted that Mr. Fletcher Moulton had misinterpreted the purport of Sec. 20, and also the purport of the clause in the provisional agreement. Inside the scale he submitted they were entitled, subject to the principles of undue preference, to give special conditions where people took a quantity, and where they had a day load as well as a night load. He thought it was plain, looking at Sec. 8, that what was preserved as regarded equality was the scale of charges, and he maintained that the prices had been equal, but he admitted that if they went into it, it meant an interminable discussion practically as regarded the particular conditions of each contract.

Mr. MOULTON contended that he was entitled to see the mid-London special contracts, because, in seeing what price the company could exact from people in Marylebone based on their present system of supply, he must see what special contracts there were which fixed their scale and their special circumstances. They would see that 6d. was the nominal price, so that there must be a very large proportion of their supply which was not at the printed scale. It did not mean that what they chose to print should be the same in the two cases, but that their rate of charge should be the same in the two, and they had a right to see those contracts, because if they found that that much lower average price was due to the fact that under substantially similar circumstances they had a lower rate of charge in mid-London than they had in Marylebone, their profits were not unduly smaller, and the value of their undertaking which they had been basing on that was thereby also smaller.

Mr. C. A. RUSSELL, K.C., the umpire, having consulted with the other arbitrators, said they were of opinion that at the present time, at any rate, the Borough Council were not entitled to the production of special contracts relating to any area except the Marylebone area. Although, however, they did not consider those contracts relevant at the present time, if any case was shown, such as Mr. Fletcher Moulton had suggested, that the charge in the mid-London area was much lower than it was in Marylebone, and if the case of the borough was attempted to be met by the company by the suggestion that the price was pulled down, not because there were under-charges, but because the special contracts were more numerous, and the circumstances of the people in Holborn entitled them to lower terms, then it might become material to see if that answer was established, and for that purpose to look at the special contracts in Holborn.

Mr. CONACHER was still under examination when the proceedings were adjourned.

Dudley.—The Corporation has applied to the L.G.B. for sanction to borrow £22,000 for the electric light undertaking.

PARLIAMENTARY.

Lord Windsor's Tube Committee.

The Select Committee of the House of Lords, presided over by Lord Windsor, resumed their sittings on Monday last, in the Grand Committee Room, Westminster Hall, and continued their inquiry into the group of underground Railway Bills referred to them. The Committee proceeded with their consideration of the scheme of the combined Piccadilly and City, London United, and North-East London Railways for an underground railway from Hammersmith to the City.

Mr. Fitzgerald, K.C., for the Central London Railway Company, whose proposal for the construction of a line from Hammersmith to the Bank was, with the exception of a small loop at the City end, rejected by the Committee at the last sitting, said all it was proposed to proceed with in their Bill was the provision for the acquisition of land for the enlargement of their station at Marble Arch. That land was the property of the Duke of Portland, and its acquisition was not opposed. They also asked for power to raise new capital to the extent of £150,000 for the acquisition of land and the construction of rolling stock.

Sir Henry Oakley (chairman of the railway) having given formal evidence in regard to these matters,

The Committee passed the preamble of the Bill so far as it related to the land and new capital.

Mr. Balfour Browne, K.C., said that since his withdrawal of the Bill of the City and North-East Suburban Company for the construction of a line from Whitechapel to Waltham Abbey, the local authorities had approached them with a request that they should proceed with their railway, believing that some means would be found hereafter of getting from Whitechapel into the City by an unobjectionable route. Messrs. J. S. Morgan & Co. had agreed to give financial support to the line. He desired to ask the Committee whether, if he succeeded in getting the order of the House of Lords for the withdrawal of the Bill discharged, they would hear him in support of their proposal.

Mr. Littler, K.C., for the North London Railway, said this was an extraordinary application, to which he took the strongest objection. The City and North-East Suburban Company deliberately took their chance. They did not succeed, and they withdrew their Bill. By that choice he submitted they must abide.

The Chairman announced that the Committee could not give any support to the application.

Mr. Balfour Browne said he believed the only opposition remaining to be heard against the combined line from Hammersmith to the City and to Palmer's Green was that of the frontagers, and the promoters had framed a clause expressing their view as to how the frontagers ought to be dealt with. It was drawn up on the lines suggested by Viscount Knutsford on May 15th, so as to place for a limited period after the opening of the railway, the owners of lands and houses that were not taken on the same footing as the owners of lands and houses which were taken for the purposes of the railway. The words "injuriously affected" had been incorporated in the clause in accordance with the suggestion of Viscount Knutsford, and he believed that by its terms the views of the Committee would be carried out.

The Chairman said he would like all parties interested to carefully consider the clause, so that on Friday, when they took it into discussion, it might be possible to arrive at a settlement.

Mr. Pember, K.C., for the Great Eastern Railway Company, asked if the Committee would state whether the preamble of the North-East London Railway might be regarded as having been passed. At present there appeared to be great uncertainty on the point.

The Chairman replied that they would not give their decision on the preamble until the whole of the opposition to the combined scheme had been heard; but if there was nothing else but the railway opposition, the Committee would pass the preamble of the Bill.

Mr. Reader Harris, K.C., then addressed the Committee on behalf of the frontagers along Kensington Gore and in Princes Gate in opposition to the railway. He said that, with the exception of Mr. Pierpont Morgan, who was interested in the railway, all the residents in the district had contributed to a guarantee fund to meet the expenses of opposing the preamble to the Bill. Their objections to the proposed line were a serious fear that injury would be caused to their property, and deteriorate it in value; that the existing and authorised railway facilities were sufficient to meet the demands of the traffic in the neighbourhood, and there was no public necessity whatever for the construction of an additional railway.

Evidence of frontagers was then called in support of the learned counsel's statement.

Lord R. Cecil, K.C., stated the opposition of the rectors and churchwardens of St. Martin's-in-the-Fields and St. Clement's Danes, Strand, to the line, which passed close to both of those churches, and evidence was given expressing a fear that some subsidence would take place, and that injury would be done to the churches, which no money compensation could meet.

The Committee having deliberated in private, the Chairman said the Committee had decided to pass the preamble of the Bill for the construction of a railway from Hammersmith to Palmer's Green. They would next proceed with the Clapham Junction to Marble Arch Railway.

Mr. Balfour Browne said there was no opposition to this railway, Earl Cadogan, the Duke of Westminster, and the Battersea Borough Council having been settled with.

Mr. Hutchinson, on behalf of the Duke of Westminster, said that, as far as his private interests were concerned, he had been satisfied by the promoters, and that from a public point of view he believed that there was a necessity for the line, and was in favour of it.

The Committee then declared the preamble to be proved. They also declared the preamble proved of the Bill granting an extension of the Brompton & Piccadilly Circus line to Holborn, to which there was no opposition.

Mr. Littler applied for an extension of time for the construction of the authorised Brompton & Piccadilly Circus Railway.

Mr. Talbot opposed the application on behalf of the Duke of Devonshire and the Duke of Wellington, on the ground that the construction of the railway would result in there being two tubes laid down from Hyde Park to Piccadilly Circus. The company obtained its power in 1897, and had done nothing. Should, however, the Committee see fit to grant the extension of time, he hoped they would not consent to the duplication of the stations in Piccadilly.

The Chairman said the Committee would grant the extension of time. The Committee adjourned.

On Tuesday the Committee again sat to consider the proposal of the Brompton and Piccadilly Circus Railway Company to construct a spur line from South Kensington to Parson's Green *viâ* Fulham Road.

Mr. Freeman, K.C., addressed the Committee in opposition to the line on behalf of the Brompton Consumption Hospital, the Chelsea Hospital for Women, and the Guardians of the Poor for the St. George's Union. He said it was proposed to construct the railway in close proximity to those buildings and to have a station in the immediate neighbourhood of the Brompton Consumption Hospital. He submitted that there was no public necessity shown for the railway, as there was no substantial number of people in the district who required to be served by the railway, which would form no part of a through route. The District Railway well supplied the needs of the neighbourhood, and that line would be more efficient when electrified. The Committee had another scheme coming before them for the construction of a railway under King's Road, Fulham, but it was not open to the objections of the hospitals as against the railway at present under consideration.

Evidence was then heard from the physicians of the Brompton Consumption and Chelsea Hospital, who agreed that absolute quiet was essential to the patients, and that the noise and vibration of the working of the railway would be extremely detrimental to their chances of recovery.

Mr. Coward, K.C., appeared on behalf of the L.C.C., and requested the Committee to reject the scheme. They regarded it as unsatisfactory, both from the point of view of finance and of convenience to the public. If the railway was sanctioned, the Council feared the line would never be constructed, but would remain as a "block" line against any other railway down either the Fulham Road or the King's Road.

Mr. Littler, K.C., for the promoters, said that as far as the hospitals were concerned, they were quite willing to put themselves under any reasonable clause, and take any special precautions decided by the Board of Trade as necessary in the interests of those buildings.

The Chairman stated that the Committee had decided that that portion of the preamble of the Bill was not proved.

The Committee next considered the King's Road Railway Bill, and

Mr. Balfour Browne, in opening the case for the promoters, said the Bill was before the Joint Committee last year, who had reported that it might be referred, in the ordinary course, if interchange stations were provided at Victoria; an extension to Putney would be desirable. Last year it was proposed to proceed as far as Eel Brook Common, but, in accordance with the recommendation of the Joint Committee, it was proposed now to construct a line from Putney, starting close to the station of the London & South-Western Railway, coming under the river on to Eel Brook Common, and so on to Victoria. It was then proposed to make there an exchange station, enabling passengers to get into the City in conjunction with the deep level District Railway. The length of the line was 4 miles 1 furlong. It was supported by all the local authorities through whose districts it passed, excepting the City of Westminster. The capital proposed was £2,598,773, and it was believed there would be no difficulty in raising the money.

Mr. J. McAlister, one of the promoters, gave evidence in support of the Bill, and in cross-examination, Witness said the other promoters of the Bill were Sir Owen Slacke, Sir Richard Sankey and Lord Teynham.

Mr. Shepherd, of Messrs. Shepherd, Perry & Scott, financiers of Old Broad Street, said he thought there were fair prospects of raising the capital for the line. If there was a favourable board of directors, he would be prepared to recommend the scheme to his friends.

The Chairman said the Committee found the preamble of the Bill not proved.

Mr. Pember, K.C., on behalf of the governors of St. George's Hospital, said he understood the West and South London Junction Railway Bill next on the list, was to be withdrawn. He maintained it was a gross abuse for a Bill to be kept on the list until the last moment, and after all the expense had been incurred by the opponents, to withdraw it.

The Committee adjourned.

Faversham.—The T.C. has decided to apply for sanction to borrow £24,100 for electric lighting purposes.

CORRESPONDENCE.

Alternating Current Theory.

The equations (20) and (22) referred to by Mr. Rhodes in his letter to you last week had not escaped my attention, and they do not answer my criticism. The first of them is as follows :—

$$\frac{i_1}{i_2} = \frac{N_2}{N_1}. \qquad (20)$$

This, as I understand it, gives an approximate value of the ratio between the primary and secondary currents when the *secondary circuit of the transformer is short circuited*. In this case the primary ampere-turns $N_1 i_1$ will be nearly equal to the secondary ampere-turns, $N_2 i_2$. In the review, I was referring to the equation given, I think, in Munro and Jamieson's pocket-book,

$$N_1 i_1 f_1 - N_2 i_2 = N_1 i_0 f_0, \qquad (a)$$

where f_1 and f_0 are the primary power factors for the current i_1 and the magnetising current i_0 respectively. This equation is a remarkably accurate one, and it will be seen that (20) is a very particular case of it.

Equation (22) gives the secondary voltage in terms of $\sqrt{-1}$, and various other quantities hard to calculate. The ordinary everyday equation is

$$E_2 = \frac{N_2}{N_1} E_1 - \left\{ R_2 + \left(\frac{N_2}{N_1}\right)^2 R_1 \right\} i_2.$$

I am sorry Mr. Rhodes thinks that it is quibbling to carp at lag and lead. Those interested in the subject will find it excellently discussed in a paper by Dr. Sumpner in this year's *Journal of the Institution of Electrical Engineers*, p. 631.

I would conclude by propounding a problem for solution by "equivalent sine curves" or otherwise. The power factor of an alternate current arc with hard carbons is less than unity. P.D. and current waves for this case have been drawn or oscillographed by Hopkinson, Blondel, Duddell and others. They show that the current and voltage are always zero at the same instant. Must the equivalent sine curve of the current in this case be drawn lagging or leading the P.D. wave?

Your Reviewer.

London, *May 23rd*, 1902.

An Open Letter.

You will, of course, pardon my remarking that I do not think much of the articles in your Journal as a general rule. They do not seem to teach me anything, and that, I take it, is the criterion of a useful article.

Now, I have always suffered from an excessive modesty, and I know, therefore, that, having brought myself to the point of writing to you, what I write must be going to fill a long-felt want, and must be substantially correct; therefore you will be good enough to put up a notice in your paper that correspondence on the contents of this letter cannot be tolerated. I am by no means a bigoted, or narrow-minded man, but I feel that it would be such a waste of time for controversially inclined folk, who are not so well informed on these matters as myself, to endeavour to refute my statements. First of all I think you ought to know, and will be interested in knowing, who, and what, I am.

Briefly, then, I am a well-to-do grocer in a town boasting me as one of its councillors, and having, in addition, an installation of electric light. There is, moreover, a considerable electric car service, so that you will own I live in an atmosphere that must be saturated with electricity, accounting, doubtless, for my assimilation of a certain knowledge of the science. My early training, and environments, were such that I often wonder why I continued to follow the profession of errand boy and window-cleaner in my father's emporium, and finally graduated behind the counter; but I as often console myself with the thought that genius longest hidden burns brightest in the end.

Almost before I had forgotten the feeling of a nascent front tooth, my attentive parents must have discovered in me a thirst for science equalling my more natural desire, for they demonstrated before me the essential facts of magnetism with the aid of a few tin ducks and a magnet with inconsequent poles.

In those days I continually heard grave elders remark that electricity was in its infancy, and as I lay in my nurse's arms (so forward was I) I used to think how nice it was that we two—electricity and I—would be growing up together; but, as I am still led to understand that little electricity has not been put into shorts yet, I feel that I have outstripped progress.

Since the days of the magnetised ducklings I have possessed large horse-shoe magnets of my own, and I have charged the glass and zinc cells that work the bells, and I have watched a friend of mine who combines electrical engineering and ironmongery connecting up such intricate things as the indicators for bells. This friend pays about 30s. a year to put A.I.E.E. after his name, and sometimes goes to London to take tea with his professional brethren.

In addition to this experience, my son has a friend who is a motorman, or an assistant engineer, I never quite understood which, on the tramways (I think he must be a motorman, because I know that the motormen get more than the assistants, and I am sure my son would know only the best class.)

My son picks up a lot of curious information from this quarter and retails it to me.

Since I have been on the Electricity Committee of the Town Council I have gained most valuable experience, and am pleased to think I have not been slow to give less fortunate, or less teachable, people the benefit of it. Alas, how often one finds that one's best efforts to increase the world's quantum of intelligence are ill received—even, at times, rudely rebuffed! For instance, it was not long since that I dropped in at our electricity works—we supply light to the town at a loss, and power to the traction company at a large profit—as I often do, just to assure myself that everything is going smoothly. I found our engineer storming like a madman at the poor firemen, who appeared unable to raise enough pressure. I dislike, above all things, an exhibition of temper, especially before one's subordinates, so, the force of example being proverbial, and seeing, in my quick way, an easy solution of the present difficulty, I pulled the lately purchased evening paper from my pocket, and stepped silently and calmly to the nearest furnace. The door of this I opened, and immediately clapped the paper over the orifice, merely following therein the practice of the housemaid who wishes to rouse a sluggish fire to life. Who would have believed that such a simple action could cause results so curious and diverse in the beholders! What the engineer said I cannot repeat, and only partly understood, and I did not remain longer in the place when I saw the firemen drop their iron implements and double up with laughter. An incident such as that only proves the more conclusively how widespread is the ignorance of common things. Now, I have never seen any mention in your columns of the foregoing elementary recipe, nor of that other which recommends a vertically placed poker to the same end. In my opinion, no boiler house should be without its "drawing poker," if I may coin the word.

Of course, before we decided to give the town an electricity station, we had to travel over most of Europe, and the whole of the British Isles, in order to make quite sure that electricity was the best illuminant, and to decide as to the best method of generating it, that is to say, whether statically or on the multiple unit system, or again alternatively. That reminds me of a little incident that occurred when I was going over a station towards the end of our labours. The engineer warned us not to go too near the machines if we wore watches. I showed mine to him, and said it would not be affected as it had already stood 2,000 volts on an alternator. He laughed, and asked me where I had held it, so I told him only a foot or two away from the commutator. He laughed again, and said that evidently the watch would be all right in his station as the power was only 200 volts. As a matter of fact, the thing has never gone properly since, and I cannot make up my mind as to whether the engineer or I was the fool.

We had a very enjoyable and instructive time on the Continent, and the engineer whom we had taken with us, was able, with our assistance, to compose a long and valuable

report; but, when this was presented to the committee, those members who had not gone with the deputation were not able to satisfy themselves that we had seen all that we might, and felt so much anxiety at the bare possibility of our having missed just the one system which might be going to revolutionise the supply of electricity that they resolved, and obtained the sanction of the Council, to go out themselves, determining even to take in America on the way home.

I am always thinking of little things which might help to make our station pay better. Sometimes I lie awake all night working out some idea from its small beginning to its finished state, perfect in every detail. It was only last week that an epoch-making scheme occurred to my restless mind, and I positively had to get up at 4 a.m. to tell the engineer; for I thought what an incalculable loss it would be to the world if I died, or went mad, before the morning came, and I was unable to unbosom myself of my secret. Now, in a few words, what I put before the engineer was this:—In the ordinary way you have an engine driving a dynamo which gives out current, this current first lighting lamps, or driving tramcars, and then going back to the dynamo. *Why not intercept that current on its homeward path and turn it into a storage battery?* It would then be the easiest thing in the world to drive the dynamo by a motor supplied with current from the battery. That is to say, after once starting the dynamo, no steam engine is needed, and, of course, no boilers or coal. If this was done, power and light could be sold for next to nothing, or we could make such a profit out of our consumers as to reduce the rates to nothing, or even pay a bonus! You will not fail to note, too, that I cared nothing for the vast wealth I could have gained by patenting the scheme, but wished only that all the world might benefit without enriching me by a penny.

You will, no doubt, picture to yourselves this engineer listening with rapt attention and breathless wonder, as I unfolded my glorious news! You will see him as I ended, either throwing himself at my feet in acknowledgment of my genius, or embracing me as a brother! Sirs, your visions are far from the truth. Jealousy, mad jealousy; anger, that I should have usurped his province, outshining him on his own ground, overcame this selfish bigoted man, who, with a torrent of foul abuse, in his night shirt, thrust me with rude hands into the street. Not content with that, he has so worked on the minds of my fellow-councillors and townsmen, that if I do but mention the matter I am laughed down as if I were a lunatic.

In the hope and belief that I shall be appreciated at my true value by you and your readers, I have written this, and I shall be pleased to allow you to place me on your list of occasional contributors.

U. D. C.

The Institution and Electrical Legislation.

Mr. Byng's inability to recognise the identity of interest between the electrical manufacturing industry and the electrical supply and traction industries, is quite incomprehensible. The manufacturer of engines, dynamos, motors, tramcars, cables, lamps, &c., is obviously affected by political obstruction to schemes which in their execution would create a demand for these commodities. Surely the first thing the manufacturer wants is business, and if it can be shown that municipal interference and restrictive legislation are preventing the full exercise of electrical engineering skill in this country, the manufacturer must make common cause with those who are only too anxious to give him orders as soon as Parliament allows them to get to work.

Only a few years ago the motor car was practically prohibited in this country by the regulations as to speed and precautions against manslaughter. Would Mr. Byng contend that British manufacturers who could otherwise have done a profitable business in motor cars were not interested in the removal of those official restrictions? Substituting tramway equipment for motor car manufacture, the other conditions remain very similar. When a local authority withholds its consent to an electric traction or supply scheme, it is at the same time withholding its consent to the increase of business among the manufacturers who would supply the machinery and plant for that scheme.

T. C. Elder.

Grocer and Electrical Engineer.

Little in the shape of a combination of trades is surprising in these days when desperate travellers induce French polishers, paper-hangers, furniture removers and the like to describe themselves as "electrical engineers," on the strength of the successful installation of a front door bell.

The mixture of groceries with electric lighting accessories, which may be seen in a first-class street within a mile of Charing Cross, is, however, sufficiently novel to bring to your notice, with a suggestion that even manufacturers of accessories might see fit to draw a line somewhere.

It rather looks as if in a year or two we should see such signs as "Manglin' done here, also electricle engineerin'," or "So-and-so, chimney sweep. Lightning conductors fixed. Wireless telegraphy a speciality. Premium pupils taken."

T.

Light Railways and Land Values.

In recent papers the authors seem to consider the rise in the rental of land which follows the establishment of light railways as some sort of benefit, in fact, an argument for the promotion of light railways. And no doubt from the landowners' point of view it is a very desirable result, but from every other point of view, it is an argument against the promotion of light railways, and the less said about the raising of land values the better. The landowners are quite capable of raising the value to such a height that the railway would have nothing to carry to or from the land. These political economy questions cannot be treated in this offhand dogmatic style in engineering papers, and should be eschewed.

Many places can, and shall, be connected by light railways with advantage, but, before these railways are undertaken, the investors therein must take into account the fact that the landowners will partake to as great an extent as possible of the benefits, and thus to some extent act adversely to the growth of industry without which the railway cannot prosper. The fact that a railway shall increase the rental of land does not increase its real value, for it can produce no more with the aid of a railway than it does without it. And if the farmer is led to understand that his rent is to be increased by the introduction of light railways, he certainly will not look upon them in a friendly way. Similarly, the house builder is checked in time by the increased price of land, put up by the demand brought about by the railway.

Increased value of land is a check to suburban expansion and to agricultural industry, hence cannot be an advantage to light railway enterprise.

R. Kennedy.

Sparking Troubles.

No one having answered "Student's" inquiry in the Review of May 18th, I may help him by the following:—To prevent sparking in breaking magnet circuits working on 100 volts or more, the magnet should be wound differentially, thus giving a non-inductive magnet. One coil carries a constant current, while the other wound the reverse way carries the make-and-break. When the two currents are "on" there is no magnetism; when one is broken the magnet is excited. There being no induction at break there is no sparking.

The best book on magnetism for these and kindred problems is Prof. S. P. Thompson's "The Electro-magnet."

Rankin Kennedy.

ELECTRIC LIGHT AT ST. PAUL'S CATHEDRAL.

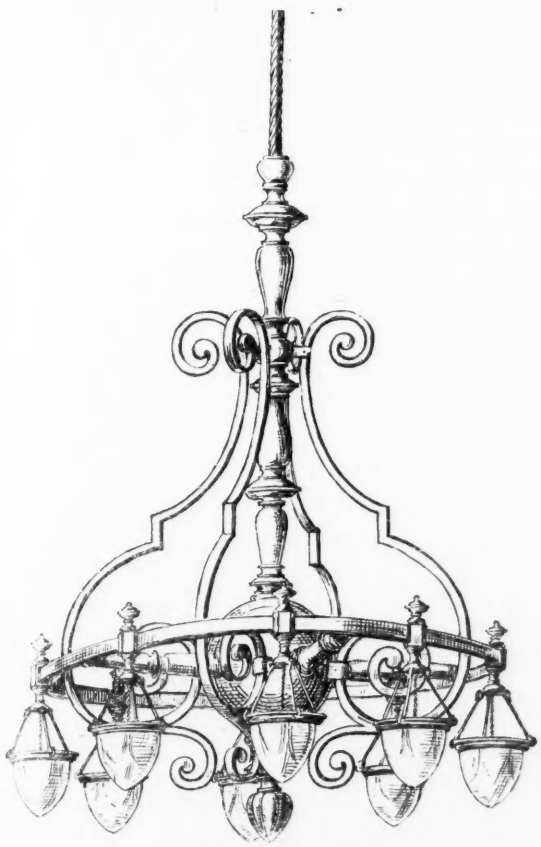
The electric lighting of St. Paul's, which has been in progress for upwards of three years, has now reached a stage of partial completion, and was used for the first time generally throughout the chancel, dome, nave, and crypts at Whitsuntide. The installation, which has cost nearly £10,000 so far, is a gift to the Dean and Chapter from Mr. Pierpont Morgan, who, we learn, has promised to increase his donation to cover the whole outlay. The difficulties of wiring and lighting so immense a building are considerable, as, apart from the care necessary in piercing thick stone walls and floors, now 200

years old, the distances to be traversed are very great, and the basement is a network of tombs and vaults, which have to be avoided.

The work has been carried out in an admirable manner by Messrs. W. A. S. Benson & Co., of New Bond Street, the well-known electricians and art metal workers, under the superintendence of Mr. Somers Clarke, F.S.A., the consulting architect to the Cathedral, and Prof. Kennedy, the consulting electrical engineer.

Choir Pendant.

The fittings, which were designed by Mr. Clarke and cast by Messrs. Benson, consist of six large pendants of cast and gilded brass in the choir, hanging from the vault, which, in addition to lighting the floor, throw a glow on the mosaics of the vault by means of upturned lights concealed in cups. There are also eight



Pendant under Dome.

heavy bronze pendants under the dome, and two others in the transepts; four gilt bracket lights upon the chancel screens; and a 10-light fitting in the apse, which also lights the Jesus Chapel. The five tall standards in the nave and two at the west entrance were designed by Mr. Penrose and Mr. Pegram respectively.

In addition to these, the choir desks have been fitted with standards holding concealed lights, and the crypt has been lighted throughout with the handsome old gas fittings in the shape of hanging Roman lamps, which have been adapted to electric light.

The same adaptation has been made in the case of the Pegram and nave standards, the bases and pillars of which remain as before, the heads, carrying electric lights in basin-shaped glasses, alone being designed afresh. These glass bowls transmit a beautiful quality of light, and were the result of many experiments on the part of Mr. Benson.

The choir aisles, the entrances, the consistory court, the whispering gallery, and several other points in the church have yet to be lighted, or provided with their permanent fittings. A few of the large pendants in the dome and transepts have their places at present filled by temporary but solid-looking structures of wood and iron. These, together with the arduous work of channelling and piercing the stone walls to receive the steel tubing in which the wires are carried, must be credited to the Cathedral's own staff of workmen, under the clerk of the works, Mr. Harding.

The supply is at 200 volts, half the load being taken from the City of London Electric Lighting Company and half from the Charing Cross and City Electricity Supply Company, both companies bringing in mains from different sub-stations. The circuits are laid in duplicate throughout the whole building, so that the lights are supplied alternately from the mains of the two companies.

Nave Standard.

The switchboards are of the central station type, on heavy slate bases, the whole of the connections and metal work being specially designed by Messrs. W. A. S. Benson & Co., Limited. The cost of the switchboards was nearly £500. The two main distributing boards, with meters and switches for the nave standards and dome, are placed in a fireproof recess off the staircase in one of the main piers leading to the Whispering Gallery. From these, sub-mains are run to various points, notably to the large distributing board in the crypt, where the switching arrangements for the chancel are situated. Smaller distributing boards are placed at various points in the crypt and at the head of the Whispering Gallery staircase.

The wiring is laid in iron barrel, the lateral distribution being mostly hidden under the crypt floor, and made accessible by means of inspection boxes, placed at frequent angles and intervals, on account of the complication arising from the tombs and vaults. The vertical cables, where possible, are carried in the hollow centres of the main piers, which might almost have been designed for the purpose.

Owing to the length of the runs, the cables are unusually large, the current density allowed for being about 250 amperes per square inch, with the result that there is scarcely any appreciable drop. The large pendants in the chancel and dome (the latter weighing over ¼ ton) are suspended by means of the cables which supply the current, the weight being taken by the outside covering, which consists of an armouring of steel wires. It is calculated that about 16 miles of cable have been used in the installation. The electrical work

has been designed and carried out under the personal supervision of Mr. C. J. Scott, chief electrician to Messrs. W. A. S. Benson & Co., Limited, of 82—3, New Bond Street.

ELECTRICAL DEVELOPMENTS AT MANCHESTER.

On Tuesday last the new electrical generating station of the Manchester Corporation, which is situated on land in Stuart Street, Bradford, Manchester, was formally inaugurated. The event was made one of civic importance, and was participated in by members of the City Council and a large number of invited guests. The scheme is one of great interest and importance, from its extent, from the character of the principal items of machinery which it will comprise, and from the rapidity with which progress has been made since the work of erection began. As Dr. A. B. W. Kennedy remarked when speaking at the luncheon which followed the opening of the station, everything had been hurried, but nothing had been scamped.

The Stuart Street installation comprises two distinct schemes—the Kennedy scheme, the first part of the power plant of which was started on Tuesday, and what is known as the Metzger scheme. The last has practically yet to be carried out in its entirety, on land adjoining that on which the buildings and plant of the Kennedy scheme will stand. The Kennedy scheme provides for the erection of steam machinery of 15,000 H.P. in the aggregate, and of electrical generating machines of 9,000 KW. in the aggregate with additional subsidiary generating plant for exciting and balancing. In connection with this scheme there will also be 10 sub-stations, and a cable subway 940 yards long, 10 ft. high, and 5 ft. wide. The cost of carrying out the Kennedy scheme, exclusive of the cost of the land, but inclusive of mains, will be about £492,000. The Metzger scheme, which is that of Mr. G. F. Metzger, electrical engineer to the Manchester City Council, provides for the addition of two larger sets of engines and generators. The engines are to be constructed by the Wallsend Slipway and Engineering Company, and will be of 6,000 H.P. each, giving a total additional horse-power of 12,000. The generators for all the sets, will be supplied by the Electrical Company. The cost of the Metzger scheme will be about £450,000, including the mains. The cost of the land for the two schemes has been, in round figures, £25,000. The total cost of the two schemes and the land will therefore be about £967,000.

The main generating plant of the Kennedy scheme will comprise six sets of vertical cross-compound condensing steam engines, by Messrs. Yates & Thom, each set of 2,500 H.P., with a 1,500 KW. three-phase alternator fixed between the high pressure and the low pressure engines. This will represent the total of 9,000 KW. above referred to. Of these six sets, one was complete on Tuesday last. A second was nearly complete, and will be got to work with all expedition.

The demand for electrical energy in Manchester has increased so rapidly during the last two years, that in the early part of last year the Electrical Committee were almost at their wit's end to know what to do to meet the demand. The consumption of electricity last year was 10,502,299 units, and the Committeee anticipated that this quantity would be nearly doubled during the ensuing 12 months. The committee therefore appointed a deputation early last year to confer with Dr. Kennedy, with a view to finding a way out of what was felt to be a serious difficulty. Subsequently, under Dr. Kennedy's advice, the erection of the Stuart Street depôt was commenced in July, 1901. So far as was practicable, the work of the different contractors was pushed on concurrently and proceeded night and day. One of the first considerations being to secure an available supply of electricity, the construction of two of the steam and generating units was hastened as much as possible.

Apart from the two units which have been erected in one of two bays which will form the principal part of the generating house, and the auxiliary machinery connected with these units, the station is as yet in an unfinished condition, the work of excavating the foundations still proceeding in places, and the steel framework which is being used for the buildings being in course of erection in others. Of a range of 24 double-drum water-tube boilers of Babcock & Wilcox pattern, which will form the steam generating plant, some are in course of construction; six were under steam on Tuesday.

The system of electrical supply adopted, and now being worked from the Stuart Street station, is as follows:—Three-phase currents generated at 6,500 volts, at a frequency of 50 cycles per second, are transmitted to 10 sub-stations, where they are converted by synchronous motor-generators to direct current, at 500—550 volts pressure for traction, and at 410 (2 × 205) volts for lighting and power purposes.

On the arrival of the party at the main entrance to the station on Tuesday, the Right Hon. James Hoy, L.L.D., Lord Mayor of Manchester, addressed the assemblage. It was interesting, he said, to the inhabitants of Manchester that there should be such an electrical station erected in their midst, because it was significant of the growth of the town, and of the demand for electric light and energy. The greatest care and attention had been given to the erection of that building. The best skill attainable should be applied to the uses of a public authority, and he was sure it had been done in that case. They would be one with him in congratulating the committee on the rapidity with which the work had been done, and they would see that it was a right-down good job.

Dr. Robert Bishop, chairman of the Electricity Committee, addressing the Lord Mayor, said he had much pleasure in asking his Lordship to accept a gold key for opening the doors of the building. He was quite sure that as regarded all that was to be seen in that station, anyone having an intimate acquaintance with electrical machinery would say that the Committee had provided the very best.

The Lord Mayor proceeded to open the door of the building; the civic party entered, and viewed the machinery with great interest. The colossal size of the main engines and of the generators astonished those who beheld them for the first time.

The ladies of the party, with the Lord Mayor and a few Councillors, ascended to a gallery, where a miniature switch had been arranged on a temporary stand, above which rose an arch of flowers. Photographs of the group having been taken, Mrs. Bishop depressed the small switch. This caused a number of incandescent lamps which were suspended from the floral arch to glow; an electric bell rang loudly; the steam valve was opened by an attendant, and in a few seconds the engines and generator began to move. After running for a short time at full speed the engines were stopped, and Councillor Charles Jennison proposed a vote of thanks to the Lord Mayor and to Mrs. Bishop for attending to perform the opening and starting ceremonies.

The Lord Mayor having briefly acknowledged the vote, the party shortly afterwards were driven back to the Town Hall, where luncheon was served. After the meal had been partaken of, Councillor Bishop, who presided, submitted the loyal toasts.

The Lord Mayor of Manchester then proposed the toast of "Success to the Electricity Undertaking," coupling with the toast the name of Dr. Bishop. Speaking of the new generating station, the Lord Mayor said he believed the Committee had had the advantage of the best theoretical knowledge on the subject, and the best practical advice within their reach. They had undertaken the work in a large spirit and with a due conception of its importance. He congratulated the Electrical Committee that they had been able to offer the tramways their assistance. That was a matter for their very sincerest congratulation as a city council. He thought it was perfectly plain that their tramways would be not only a successful experiment but a paying work, and the sooner they got started on a job which would give them something towards the relief of the rates the better for them. Some people were trying to frighten them in relation to that, saying that Manchester Corporation were borrowing very large sums of money; that Manchester had a debt which was five times its rateable value. That was true enough. The fact of one having a large capital might or might not be a good thing, but when they turned to their assets to see how the money had been expended, and what return had been got from it, he thought they would say that it was a good thing to have a large expenditure of a municipal character. It was only fair to say that there were more risks, but they were bound to go on, and they had just as fair a chance of finding a profitable investment in that as any companies which had been started up to that time in any other industry. There were undertakings in which the risks were not as great as in electrical undertakings, but still they had no greater risks to run than had the ordinary company promoter, and they had the great advantage of keeping what might be an outside monopoly, in the hands of the public.

The toast having been drunk, Dr. Bishop responded, and said that what they had seen that morning at the Stuart Street station was only about one-eighth of what they would see 12 months hence. A very great deal of the success which they had had in connection with the work was due to the efforts put forward by the various contractors. He was not bragging when he said that the work which had been attempted in 12 months was a world's record. It was only in July last that a spade was put in the ground in Stuart Street. It was astonishing that in the whole of the work, there had not been one serious accident. They had 20 sub-stations in course of construction at the present time, some of them as large as many generating stations in other parts of the country.

The toast of "Our Guests" was proposed by Councillor Hesketh, deputy-chairman of the Committee. Dr. Kennedy responded, and spoke briefly of the inception and hurried progress of the work. He could not say that anything had not been hurried, but nothing had been scamped. Dr. Kennedy spoke in high terms of the valuable aid he had received from Mr. H. C. Gunton, his representative at Stuart Street, during the progress of the work.

Mr. J. Stottner (Electrical Company, London), also briefly responded to the toast.

Dr. Bishop proposed the toast of "The Lord Mayor," who thanked the assemblage, and the proceedings closed.

PHYSICAL SOCIETY.

Meeting held Friday, May 23rd, 1902. Prof. S. P. Thompson, President, in the chair.

Mr. T. C. Porter showed "A lecture experiment on the Ebullition of Rotating Water."

A paper by Mr. J. A. Erskine on "The Conservation of Entropy" was read by the Secretary.

A paper by Sig. G. Giorgi on "Rational Units of Electro-Magnetism" was read by Mr. Price. Mr. Price prefaced the reading of the paper by saying that both Prof. Fleming and Prof. Fessenden had advocated a partial change of units, which would leave the most important ones unchanged, and the method employed by the

author was similar to that adopted by Prof. Fessenden. The author starts with a set of three equations, which contain explicitly the four concrete units of E.M.F., M.M.F., electric current, and magnetic current, together with that of activity, and considers them as fundamental in electro-magnetism. Two fundamental units are required to express these quantities, and their product must reproduce the mechanical unit of activity. If the watt is assumed as unit of activity, there are two units ready made, the volt and the ampere, which satisfy the condition, and may be considered fundamental. All concrete units in electricity and magnetism can be expressed in terms of these, and the second as unit of time. In order to complete the system, a unit of length is required. The metre and kilogramme are consistent with the watt, and putting them together with the units enumerated in the paper, the author has built up an absolute metre-kilogramme-second system, which comprises electric, magnetic, and mechanical measures in a consistent frame.

The Secretary read a letter from Mr. Swinburne, stating that most physicists who love simplicity would be glad to get rid of "4π," but schemes for suppressing it generally moved it somewhere else. He asked if the author had really got rid of 4π or merely chained it up in another place. If a change in units were to be made, it would be an advantage to get rid of the terms electromotive force and magnetomotive force.

Prof. Everett said he had arrived at the following determinations of the author's meaning:—When μ and κ are taken into account, we have the two following identities:—(1) The dimensions of current are the same as those of magnetomotive force, or $H \times$ length, called f in the paper. (2) The dimensions of electromotive force are the same as those of quantity of magnetism divided by time—called by the author magnetic current, and denoted by g. In connection with (1), the line-integral of H for a path singly linked with a circuit carrying a current of C amperes is to be called C. This gives the unit for H in terms of the ampere and the unit of length (the metre). In connection with (2) we are to use the equation for magneto-electric induction in a circuit

$$\text{electromotive force} = -\frac{dN}{dt},$$

together with the rule that a quantity of magnetism m gives the total flux $N = m$. The unit quantity of magnetism is thus defined in terms of the volt and the unit of time (the second).

The Chairman said he had received a paper from Sig. Giorgi, giving a number of illustrations of the application of his theory to calculations. There were also some further explanations, and the dimensions of many physical quantities were tabulated in terms of the volt, ampere, and second. The author claimed to have based an absolute system on the metre, kilogramme, and second, while leaving the practical units unchanged.

The Society then adjourned until June 13th.

ON THE DETERMINATION OF THE IRREGULARITY FACTOR OF ENGINES.

By Dr. RUDOLF FRANKE.

A Paper read before the Verband Deutscher Elektrotechnicker at Dresden.

Translated from the *Elektrotechnische Zeitschrift*, October 24th, 1901

The modern electrical industry makes heavy demands on engines intended for alternator driving. These more particularly have reference to governing and a certain minimum of irregularity, without which, according to present ideas, a satisfactory supply cannot be maintained. Though usually these requirements are fulfilled, there are still cases in which one must conclude, from the behaviour of the alternators, that the irregularity of the engine introduces a highly disturbing element into the plant. The electrician is then inclined to suggest that the engine irregularity is not within the specification, whilst the engine builder endeavours to prove by calculation that the machine entirely complies with the requirements. In this way two opposite opinions are developed, which may form the starting point of a highly unedifying discussion. The need of some simple experimental method of determining the amount of the irregularity has therefore been long felt by both parties. In setting myself the task of speaking about the determination of the degree of irregularity of engines, I wish to consider the production of the irregularity, the ways and means of determining it, and the difficulties it leads to, and for this reason will treat my subject under the three following heads:—

1. The irregularity, and the auxiliary disturbances to which it gives rise, in the engine.
2. The different possibilities and methods for the determination of the degree of irregularity critically set forth.
3. Considerations as to the meaning of the degree of irregularity to the electrical engineer.

Every engine in which a reciprocating motion is converted into a rotary one shows, as is well known, on account of the differences of tangential pressure, an irregular rotary motion, and, in consequence of this, even when the engine is running at a perfectly constant number of revolutions, shows varying angular velocities within a single revolution. These usually repeat themselves in the same way periodically every revolution.

Now, one can consider every irregular rotary motion as made up of a perfectly uniform rotary and a superposed swinging one whose period corresponds to the time of either a single revolution or a number of revolutions. In order to obtain a measure of the amount of irregularity, the conception of the irregularity factor has been introduced, which is defined by the relation of the difference between the maximum and minumum speeds to the average speed.

This definition, taken strictly, applies only to one revolution, for, with any alteration in the number of revolutions, the average speed, and therefore, also the value of the irregularity factor, will alter. Now, whoever has tried at any time to determine with fair accuracy the average speed of an engine, avoiding inaccurate tachometers and speed counters, will have found that every machine afflicted with any irregularity will show a continued variation in the number of revolutions, even on absolutely constant load. One can easily carry out this experiment by measuring the voltage of a separately excited continuous current dynamo direct coupled to the engine in question by the compensation method. One will then find that the voltage, which is proportional to the number of revolutions, does not keep constant for an instant, but constantly rises and falls.

These speed variations, which exist because the time taken to make a revolution is variable, occupy a much longer time than the variations during a single revolution; they occur sometimes periodically but at other times quite at random, and are usually of less importance in steam engines than in gas engines. Their amount varies from one or two thousandths up to several per cent.

These variations usually arise without anything having altered in the governor or fittings of the machine. The cause of these effects is, in my opinion, partly to be looked for in the irregularity of the engine itself, through which parts capable of getting up a swing, like fly-wheels with flexible shafts and spiders, in combination with the elastic volume of steam in the cylinders, are set into resonant vibrations, and as these will usually coincide with other periodic times, a combined motion is produced. One must, however, put the effect down partly to shocks in the engine as well as to unequal energy supplies during the different revolutions. Even though the variations in time of revolution are usually so small as to be harmless for many purposes, they are still of importance to the user of alternate currents, as I shall show later on. They form a highly disturbing element in the determination of the irregularity factor. We have therefore to deal with a combined velocity which

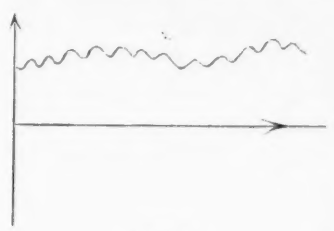


Fig. 1.

may be represented approximately as in fig. 1, in which the small waves indicate the changing angular velocities during a revolution and the larger fluctuations the variations in the time of revolution.

Only a few years ago an irregularity factor of $\frac{1}{100}$ was considered a very small one; to-day one goes up to $\frac{1}{300}$, or even $\frac{1}{500}$. I shall, towards the end of my paper, touch on the question as to whether there is any object in keeping to such small values, especially considering that the changes in time of revolution are greater than the irregularity factor itself. The determination of the degree of irregularity becomes more difficult the smaller it is, as the following example will show. Suppose it is required to determine an irregularity factor of $\frac{1}{300}$ with a degree of accuracy of at least 10 per cent., that would mean that the $\frac{5}{1000}$ part of the average velocity must be measurable with an accuracy of 10 per cent—that is to say, the $\frac{5}{10000}$ part of the average velocity must be measurable. This, however, is an exactitude of measurement which is impossible with ordinary means. The irregularity factor has different values, due to intermediate twisting, according to the point at which it is determined, whether on the spindle, the outer diameter of the fly-wheel, or on the dynamo. We are naturally interested in the degree of irregularity at the dynamo, but as we cannot measure it at the outer periphery of the armature—*i.e.*, at the point where the electromotive force is induced—the apparatus must be connected to the spindle. The above fact also prevents the use of all elastic or rubbing connections. An apparatus for measuring the irregularity factor must therefore comply with the following conditions:—The apparatus must be very exact and delicate in operation, it must have no elastic or rubbing parts and connections, it must permit the elimination of the change in time of revolution. We will now consider the different methods and arrangements from these points of view, and, to facilitate reference, I have divided them into the following classes:—

1. Determination of the irregularity factor from the distances passed through in equal times or from the unequal times taken to pass over a given distance.
2. Determination of the irregularity factor from the curve of motion which shows the deviation of the irregular motion from a uniform motion occurring at the same time.
3. Determination of the irregularity factor by direct measurement of the velocities.

It is, naturally, not possible for me to give even an approximate description of the experiments carried out in this direction, and it is much more to my purpose to give only a few typical methods which, with slight variations, are constantly recurring.

The oldest methods, and at the same time those which have been most commonly attempted up to the present, belong to the first class. They are based on the arrangement probably first suggested by Radinger, in which a regularly vibrating tuning fork is made to draw a wavy line on the surface of an irregularly rotating cylinder. This method was sometimes arranged so that the engine fly-wheel itself was provided with a prepared surface on its outer periphery, on which the wavy line was drawn, or* a separate recording cylinder A was connected with the machine under test, by which the vibrating

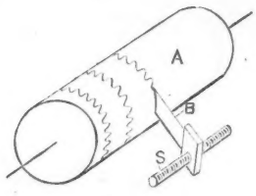


FIG. 2.

body B was also moved along parallel to the axis by means of a screwed rod S (fig. 2). The degree of irregularity could then be obtained from the different distances apart of the separate waves. When one remembers that before a new diagram could be taken, the machine had to be brought to rest each time in order to renew the prepared surface, when one further considers that the measurements of the separate waves, as drawn, can obviously not be carried out with any great degree of accuracy, and that the elimination of the variable time of revolution is difficult, one can readily understand that the method has not been applied much in practice. On this account Dr. Göpel† modified the original Radinger method so as to avoid the inconveniences as far as possible, and, by means of an ingenious mathematical treatment, to make it possible to partly eliminate the inaccuracies introduced by unequal times of revolution. This alteration consisted in replacing the cylinder by a disc connected directly to the shaft of the engine under test by means of a wooden frame. The record was produced by a tuning fork moved by hand from the centre of the disc radially outwards. Though relatively good results were obtained by this method, it must be remembered that the machines tested had comparatively large irregularity factors, viz., $\frac{1}{80}$. If the irregularity factor exceed $\frac{1}{100}$, the method becomes unworkable, because the measurements of the wave lengths of the diagram become so small that their accuracy cannot be depended upon, especially considering the other disturbing cause (changeable time of revolution). To this class of methods also belongs one in which the variations in angular velocity are determined by the note given out by a vibrating body set in motion by a many-toothed wheel revolving with the irregular motion. The different notes of the tuning fork show that the same

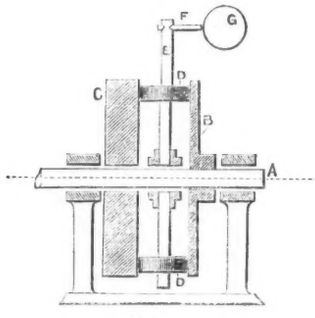


FIG. 3.

distance, namely, the distance between two teeth on the toothed wheel, is passed over in different times. Only very large irregularities are perceptible to a trained ear, so that the method must be entirely rejected.

We come next to the class of methods which enable the irregularity to be determined by measurements of the difference in motion between a body rotating with irregular velocity and one rotating with a uniform average velocity. It is by no means sufficient to determine the greatest differences, or, in a certain sense, the amplitudes, of the fluctuating machine relatively to the uniformly rotating body. For just at the moment when the greatest amplitude is reached the machine is standing still relatively to the uniformly rotating body, and is therefore rotating with the average velocity. We wish, however, to determine the greatest and least velocity of this fluctuating motion, and can only attain to this by plotting the whole course of the irregular motion as a curve. So that apparatus intended for the determination of amplitude of motion, which is also liable to errors through variable time of rotation, can never serve for the determination of the irregularity factor and is only of indirect interest to the electrical engineer. Thus, for instance, the apparatus of Aichele*, in which a pencil marks the amplitudes of the irregular motion as the arc of a circle on a uniformly rotating mass, can in no way be used for accurate observations, because here variations in time of revolution introduce indeterminate variations in the amplitudes. It is different, however, with the method of Görges†, which may be described as a stroboscopic one‡. In this the uniformly rotating mass is replaced by uniform light impulses which represent the average velocity of the machine under test. With this method a definite position of the machine is indicated by each light impulse, so that one can readily observe the to and fro motions. It is, therefore, possible to observe the effects of irregularity and of variable time of revolution through the different types of amplitude, but it is not possible to determine the irregularity factor itself.

For the purpose of obtaining the curves of combined motions, somewhat complicated apparatus is necessary. Practically, nothing is to be found on this subject in technical literature, probably because most of these attempts failed. Only the German patents, Nos. 50,569, 81,572 and 84,817 deal, and all in a somewhat similar manner, with such methods. I will, therefore, describe patent No. 81,572 of the firm of Messrs. Schäfer & Budenberg in detail below. A spindle, A (fig. 3), on which a disc, B, is fixed, is rigidly connected with the engine. A mass, C, also rests on the spindle, A, about which it is free to turn. Between the disc, B, and the mass, C, an auxiliary drive, D, is arranged, whose wheels turn on a vertical spindle, E. A pencil, F, for the purpose of drawing the required curve on a drum, G, rotating with uniform velocity, is fixed to the end of this spindle. Consider the spindle, E, as held in a certain position of rest by springs, then the motion of disc, B, will be transmitted by the auxiliary wheels, D, to the suspended mass, C, and the latter will, after a time, take up an average velocity. Every difference between the velocities of B and C will, in consequence, carry the auxiliary wheels, D, and their spindle, E, over towards one side or the other, by which means a deflection of the pencil occurs, and a curve will be traced on the drum, g. A curve is thus obtained approximately, as shown in fig. 4, which actually records nothing

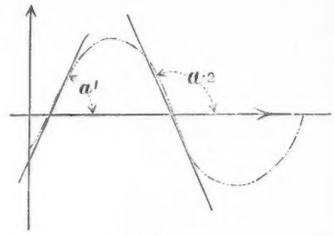


FIG. 4.

further than the difference between the two motions. It is, however, a curve of motion as well, whose slope gives the instantaneous velocities. In order to determine the velocity at each instant, one would, therefore, have to deduce a velocity curve by differentiation of the curve of motion—a very involved process.

For our purpose it is, however, sufficient to determine the maximum and minimum velocities, and for this it is only necessary to draw tangents to the curve at those points where it rises and falls most steeply. The irregularity factor is then

$$u = \frac{c\,(\tan a_1 - \tan a_2)}{2\,r\,\pi\,n},$$

where n represents the number of revolutions per second of the drum. The mode of action of this apparatus is by no means free from objection, since the auxiliary wheels do not exclude the possibility of slipping, and consequently introduce errors, whose amount cannot be discovered, into the result. As the apparatus was not sensitive enough to determine the irregularity factor, it soon fell out of use.

(To be continued.)

WATER SOFTENING.

IT is quite common to suppose that where surface-condensing is carried out and satisfactory elimination of oil has been effected, there is no need for water treatment. This is on the whole true when the circulating water comes from a river or a canal or other copious source, but it is by no means true where the water is small in quantity and is cooled by evaporative means, as in a cooling tower. All these evaporative coolers act by the absorption of heat by that portion of the water that disappears. Fresh water is

* See Grabon in *Zeitschrift "Stahl und Eisen,"* 1899.
† *Zeitschrift der Verband Deutscher Ing.*, 1900.

* *Elek. Zeitschrift*, 1900.
† *Elek. Zeitschrift*, 1900. Part 10.
‡ See also Benischke *Elek. Zeit.*, 1899. Part 17.

added to make up the loss, and it follows that in time the whole of the water that remains must be in a fully saturated condition in respect of all its soluble impurities.

Thus we find that incrustation takes place on the condenser tubes, which are thereby seriously reduced in efficiency. When water is at the saturation point with any salt, such salt will deposit on very slight provocation. Thus a water saturated with carbonate of lime will deposit some of this, even with the moderate heating given to it in a surface condenser.

There are three remedies that at once suggest themselves. The first of these is the treatment of the make-up water before it enters the cooling tank. The ordinary caustic lime and carbonate of soda process will deal with the lime carbonate and sulphate, and so remove these before the water mixes with the general body. But the process does not wholly remove the scale-forming salts. A fraction remains, and this fraction is continually being added to, and complete saturation is after all only delayed. To delay this time as much as possible, it ought to be the practice to save every drop of rain which falls on the area of a power station, and conduct it to the water store.

A second method is so to construct surface condensers that the pipes may be fitted with continuously moving scrapers, similar to a fuel economiser, to remove the deposit as quickly as it is formed. There are some doubts as to whether this would be fully effective. We do not know that it has ever been tried, but we incline to think it would act. The primary objection to it is that the bulk of the surface condenser would be increased considerably. A third method, applicable to carbonate scales, is to destroy the deposit by means of acid. Sulphuric acid or hydrochloric acid both set free carbonic acid gas from lime carbonate, and thus destroy the deposit by solution; while care is necessary not to destroy the tubes, we should consider it probable that, so long as any scale remained to be attacked, the acid would not attack the metals, and we have seen condenser tubes thus treated without themselves being damaged. It may be worth while for station engineers, who have detartarisers in use, to consider the passage of all make-up water by way of this apparatus, discharging the water condensed in the surface condenser into the general store. In this way only soft water would enter the store, and all make-up would pass through the boilers by way of the detartariser. Unless the water first passed through the economiser, the benefit of this would be lost, and this is the principal objection to the method, because it involves deposit in the economiser. In all cases the cooling tanks should, if possible, have a hopper bottom to serve as a sludge collector, and admit of blow-out without too serious a loss of water.

Even when the make-up water is softened, the general store will, as above stated, become fully charged in time by the accumulated fraction of salts which remains. The whole tank of water may then, of course, be treated and made to deposit most of its load of scale-forming matter. In spite of every care, there will be in time accumulation on condenser tubes.

As regards the system of allowing the condenser discharge to pass to the general store instead of to the boilers, there would accrue the advantage of avoiding grease in the boilers. The grease would accumulate in the tanks, and could be removed from the surface as it separated out from the water.

In treating lime carbonate with dilute sulphuric acid, the products formed are lime sulphate, water and carbonic acid gas, and when a condenser is thus cleaned, the wash-out should be run to waste, not allowed to enter the tanks.

There is a further method of purifying water that has been overlooked. Where detartarisers are worked by exhaust steam it is not possible to condense, and the benefit of the economiser is lost where detartarisers work on the continuous system. For every pound of steam used by the engines, only about three-quarters of a pound are needed as make-up of the cooling water. With the make-up supplied at nearly 80°, as can easily be arranged, there will have to be added to it 132° of temperature in order to boil it. Each pound of exhaust steam at 212° can part with 966 units of heat in order to boil the make-up water, or it will boil over seven times its weight of water. As the weight of make-up is but three-fourths the weight of feed, it may be stated that by running non-condensing for one hour in ten, all the make-up water may be heated to 212°, so as to deposit its load of scale-forming matter. A similar and continuous effect may be secured by taking one-tenth the total steam from the intermediate receiver of a compound engine.

The foregoing may serve to point out certain unsuspected difficulties of surface condensing where there is only a limited supply of circulating water, and to emphasise the real value of economising all rainfall. Where circulating water is free and abundant, there is always a demand for some 5 per cent. or so of make-up water for the boiler feed. This may with advantage be purified by some of the usual methods, especially by the detartariser. Where the draught and other conditions will admit of it, the make-up may be obtained by evaporation under low pressure from a flue-heated vessel placed in the flue between chimney and economiser, and connected to the condenser. The steam thus drawn off at low pressure would be dealt with continuously by the condenser, and deposit would occur in the evaporator, a vessel whose position would prevent any severe heating, so that probably the deposit formed at a low temperature would easily be removed, for it would be very easy to arrange such an apparatus with a mud box outside all heat influence, and there would also be no danger in using certain of the boiler compounds which tend to preserve the scale as slush, but are very dangerous inside boilers.

The temperature of the water inside such a heater would be about 126° F., which corresponds with a condenser "vacuum" of 12·7 lbs. In marine practice make-up water is evaporated by live steam passed through coils immersed in salt water in a vessel connected, as above described, to the condenser. Though evaporated at low temperature, make-up water necessarily carries off the latent heat of evaporation, which is lost in the condenser, no matter on what system the evaporation is carried out.

The object to be kept in view in all systems of scale prevention and other water treatment is to secure the advantage of condensing and flue feed heating, which are apt to be lost where the treatment of water by the apparatus known as detartarisers is practised. Each case requires to be considered by itself, with the various points enumerated in the foregoing kept in view.

THE DESIGN OF CONTINUOUS CURRENT DYNAMOS.

By RANKIN KENNEDY.

The designing of any machine whatever is a somewhat empirical affair, but with dynamos, the most important factors in the design need not at this date be left entirely to chance, and an approximate formula may be considered worth discussion.

The first thing a designer is given is the output in kilowatts required of the machine to be designed; no formula which is not based on this fundamental requirement is of any use. The next given factor is the speed in revolutions per minute. The designer is not concerned about the value of this factor; any given dynamo can be run at very widely different speeds with equally good results. The third given factor in any design is the terminal voltage, these three factors being always given, and the formula, $E = Z \times N\ell \times n \times 10^{-6}$. Z and $N\ell$ remain to be determined by the designer, and his chief aim is to find the lowest value for Z and $N\ell$, which will give him a machine to run efficiently and sparkless.

The designer has also given him accurate tables of copper wires, their dimensions, resistances, and also their current capacity for a given temperature rise, and so on. He has also at this date accurate tables of magnetic permeability of iron, its hysteresis and ampere-turns per inch length required to magnetise it to any practical degree. He has also the experience as to laminations, pole clearance, sub-division of armature coils into many sections, slit pole-faces, carbon

brushes, and all the other little fakes used to improve a design. I have no intention of going into any of these questions, but merely to put forward a method for arriving at a value for z in the formula, so that only one unknown quantity remains, Nl, and that follows naturally, an easy quantity to determine.

The formula is $z = \sqrt{\text{K W}} \times 200$, where z is the total magnetic flux through the armature in Kapp lines, K W the kilowatts output, and 200 a constant which different designers may alter in value according to their skill. The lower it is the *cheaper* the machine; the higher it is the *better* the machine.

This formula assumes one speed of 1,000 per minute for all machines; to apply to other speeds we use another factor. For reduced speeds we divide the standard speed of 1,000 by any number required to bring the speed down to the given speed, and then multiply the constant 200 by the square root of this number. Thus if the speed were to be 250, that is, $\frac{1,000}{4}$, then the constant instead of 200 would be $200 \times \sqrt{4} = 400$.

Then for higher speeds we multiply the standard speed of 1,000 by any number required to bring the speed up to the given speed, and then divide that constant 200 by the square root of this number. Thus for a speed of 4,000, instead of 200 the constant would be

$$\frac{200}{\sqrt{4}} = 100.$$

z, then, is found by

$$\sqrt{\text{K W}} \times 200 \times \sqrt{\frac{1,000}{n}},$$

when speed is under 1,000, and by

$$\sqrt{\text{K W}} \times 200 \times \frac{1}{\sqrt{\frac{n}{1,000}}},$$

when speed is over 1,000, n being the speed given. Having thus found z, all the rest follows with ease. Of course, this formula can be written somewhat differently, but it would not be so clear in any other form for my present purpose.

With this formula we have now all the following data for designing any machine :—

K W = the output.
n = the speed.
E = the terminal voltage.
Nl = turns of wire or bars on the armature.
z = total magnetic armature flux.

$$Nl = \frac{\text{E} \times 10^6}{\text{z} \times n}.$$

All the rest of the design can now be left to any designer with some experience and a book of reference tables of iron and copper materials.

It is remarkable how few sparkless machines are to be seen after all the elaborate treatment their design has received by scientific electricians, for while their mechanical construction and artistic form have vastly improved in ten years, it cannot be said their electrical design is much improved over older machines; very few designs display any originality electrically.

BUSINESS NOTES.

Arc Lamp Exports.—We understand that Messrs. Drake and Gorham have recently received two interesting orders for Jandus arc lamps. The first is for 100 of their power circuit lamps, five in series on 440 volts, to be used for illuminating the forthcoming Durbar at Delhi. In these lamps the automatic cut-out is a complete mechanism in itself, and is, therefore, better able to protect the main coils, and to maintain continuity of circuit in the event of the main mechanism failing, than if it were actuated by the main mechanism itself. Both the line and substitutional resistances are inside the lamp case. A further advantage is that any five out of the 100 burn well in series. The other order is for their well-known standard lamp, fitted with a special air-tight case to meet the difficulties of the South African climate. These lamps are to be used for Coronation illuminations.

Electrical Wares Exported.

Week ending May 28th, 1901.		Week ending May 27th, 1902.	
Adelaide	Value £45	Adelaide. Teleg. cable	Value £242
Amsterdam..	90	Alexandria	370
Bangkok	351	Amsterdam	58
Buenos Ayres	499	Bangkok	140
,, Teleg. mat. ..	497	Bombay	119
Calcutta	1,775	,, Teleg. mat.	334
,, Teleg wire	161	Brisbane	85
Cape Town..	242	Calcutta	896
,, Teleg. cable ..	9,600	Cape Town	58
Colombo	58	,, Teleg. mat. ..	750
Copenhagen. Teleg. wire ..	92	Christchurch	10
Durban	536	Copenhagen	25
East London	228	Delagoa Bay	47
,, Teleg. mat. ..	228	Demerara	35
Gibraltar	13	Durban	1,618
Gothenburg	3	East London	669
Halifax. Teleg. mat., 92 cwt.	—	,, Teleg. wire ..	476
Hamburg. Teleg. mat... ..	300	Fouchou	19
Hong Kong	17	Fremantle	45
Kobe. Teleg. mat.	6,534	Gibraltar	121
Launceston	50	Gothenburg. Teleph. cable ..	243
Limon	17	Melbourne	305
Lisbon	50	Monte Video	20
Madras	38	Ostend	60
Mauritius	13	Port Elizabeth	1,020
Melbourne	179	Singapore	25
,, Teleg. cable ..	2,158	Sydney	645
Ostend	80	Wellington	36
Perth..	120	Yokohama	650
Port Elizabeth	74		
Rotterdam. Teleg. mat. ..	100		
St. Petersburg. Teleg. mat. ..	300		
Singapore	31		
Sydney	1,141		
Wellington	112		
Yokohama	1,228		
Total ..	£26,960	Total ..	£9,121

Foreign Goods Transhipped.

Buenos Ayres. Electric lighting apparatus	Value £180
Hamburg. Elec. goods ..	100
Madras. Elec. mat.	60
New York. Elec. motors & parts	151
Perth. Elec. goods	360
Total	£851

Books Received.—"Coal Cutting by Machinery in the United Kingdom," by S. F. Walker. London: The Colliery Guardian Company, Limited, 1902.

"Science Abstracts," No. 53, May 26th, 1902. London: The Feilden Publishing Co., Ltd. 2s.

"One and All Gardening, 1902." Edited by Ed. O. Greening. London: Agricultural and Horticultural Association, Ltd.

"A Graduated Collection of Problems in Electricity," by R. Weber, translated by E. A. O'Keefe. London: E. & F. N. Spon, Ltd. 1902. 7s. 6d. net.

Installations.—Messrs. Baughan & Co., of London Street, Reading, have recently secured the contract for the electric lighting of the large premises of Messrs. McIlroys, of Reading. The installation consists of 730 incandescent lamps, fitted in chandeliers, mostly for six lights, and 70 arc lamps of a special design of the Union Electric Company's, enabling these five-ampere lamps to be burnt five in series upon the 200-volt supply, without any resistance in circuit. These lamps are specially constructed with a gilded finish and corona, so that most of them fit flush on to the ceiling. In addition to the above, there are also 24 of the Union Electric Co.'s flame arc lamps, these being used for external and effect lighting. Messrs. Baughan & Co. are also carrying out other large arc lighting installations, with the same class of arc lamps, and installations of power in various other industries in this thriving city.

Among recent contracts carried out by the E. A.-G. vormals Lahmeyer Electrical Company, the following polyphase plants are of interest:—

Electricity works at Kubel Herisau, Switzerland, equipped with four turbines direct coupled to alternators, for a total output of 1,600 KW. at 10,000 volts pressure. The installation supplies Herisau and 15 surrounding towns with light and power.

Electricity works for the supply of Augsburg and surroundings, comprising three turbines, direct coupled to generators of 1,500 KW. each, at 10,000 volts, and three turbines coupled to dynamos of 1,000 KW. each, at 220 volts.

Works for the city of Sinaia, Roumania; three turbines coupled to alternators for a total output of 1,050 KW., at 3,000 volts. For power transmission to Campina and Bustenari, a distance of 45 km., for working petroleum purifying machines of the Steava Romana, there are four transformers for a total output of 800 KW., transforming up from 3,000 to 11,000 volts.

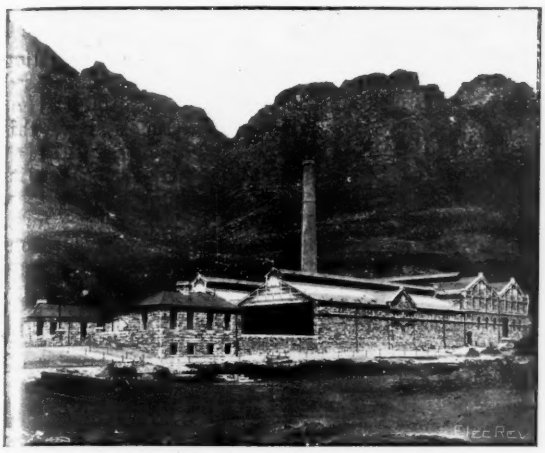
Works for the city of Wangen, Switzerland; seven turbine-driven alternators of 1,600 H.P. each; one being for reserve, the total output is 9,600 H.P. The alternators generate at 10,000 volts for lighting and power, distributed over an area the diameter of which is about 50 kilometres.

Liquidation. — A resolution was passed at an extraordinary general meeting of the London United Tramways Co., Ltd., held at Bristol on April 12th, and confirmed at a meeting on 6th inst., to the effect that as the undertaking and assets of the company had been purchased by the London United Tramways (1901), Ltd., the company be wound-up voluntarily. Mr. Samuel White was appointed liquidator for the purpose.

(*Continued on page* 905.)

CAMP'S BAY, CAPE TOWN AND SEA POINT TRAMWAYS.

THE Camp's Bay and Cape Town Tramway system, as it exists to-day, is a natural extension of the previously existing Cape Town line, although the Camp's Bay section is



POWER STATION.

owned by a separate financial organisation. The construction of this tramway, which would have been difficult enough under ordinary circumstances, was rendered much more arduous by the fact that the whole of the work was carried out during the progress of the Boer war. Not only did the course of the war interfere with shipping facilities, but no little trouble was experienced owing to the difficulty of obtaining adequate labour. In spite of these drawbacks, however, the tramway system, comprising nine miles of difficult track work, has been completed without any serious delay. The whole of the materials required, and a good deal of the supervision necessary in course of erection, were supplied by Messrs. Dick, Kerr & Co., Limited, whose experience in the construction of tramways beyond our borders has been unique, as far as English companies are concerned.

A clear idea of the extent of the system will be obtained from the map, which is reproduced on p. 904. Commencing at the Round Church, Sea Point, on the south-west of Cape Town, where connection is made with the Cape tramway, the line rises at the end of the first mile to an altitude of nearly 300 ft., and grades of 1 in 12 have been encountered. At Upper Clifton a magnificent view is obtained of Camp's Bay, the range of mountains called the Twelve Apostles standing out clear and distinct.

Gradually descending, at Camp's Bay the track leaves the roadway, and continues its course over land purchased by the company.

After passing the power station, some three-quarters of a mile distant, the most southerly point of the tramway is reached at Oudekraal. Here the line diverges in a north-easterly direction, and after encountering the heaviest grades of the system, the highest altitude is reached at Kloof Nek. At this point, some 800 ft. above sea level, there is obtained one of the finest views in the Colony. To the south is the rugged scenery of Camp's Bay and Oudekraal; to the north Cape Town and its world-famed Table Bay, while dimly in the distance lie the Blue Berg Mountains, the Lion's Head and Table Mountain being on either hand.

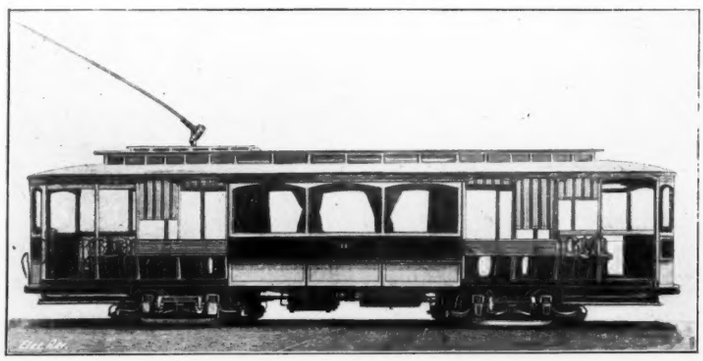
The average grade from Kloof Nek to the terminus at Burnside Road—a distance of little more than $1\frac{1}{4}$ miles—is slightly steeper than 1 in 12. Even this is exceeded in other places, where grades of 1 in 9 are encountered for short distances.

VIEW ON THE TRAMWAY ROUTE.

The laying of the permanent way involved more than the usual difficulties. Not only was a considerable length of new roadway necessitated, but more than 75 per cent. of the existing roads had to be widened and graded. Blasting operations on a large scale were necessary, which, however,

provided the compensating advantages of much excellent stone for concrete and road metalling.

Besides making provision for carrying off the heavy rains by means of capacious drains and culverts, massive retaining walls had to be constructed, consisting of dry stonework laid in courses. In places these were of exceptional strength, measuring from 6 to 10 ft. thick at the base, and from 20 to 25 ft. in height, crossing the deep sluits of watercourses on the estate.



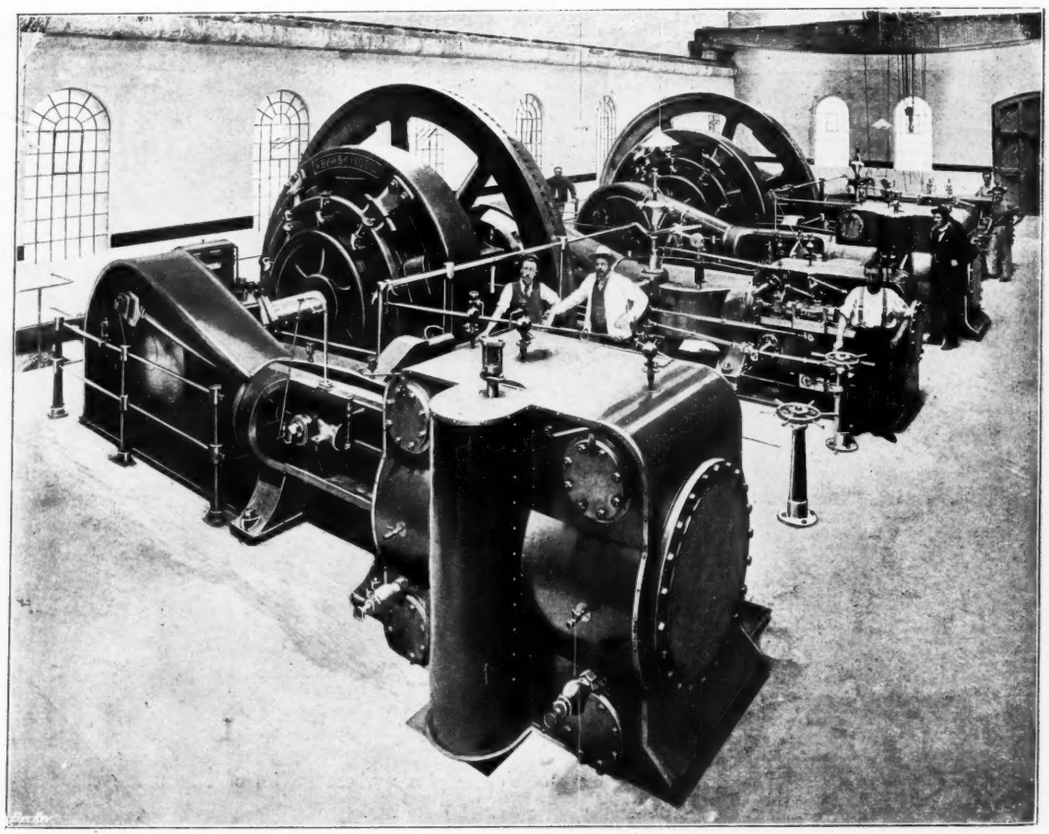
View of a "Combined" Car.

The gauge of the tramway is 4 ft. 8½ in., and is thus uniform with the Cape Town Tramways, over which system running powers have been obtained. The rails are of girder section, weighing 90 lbs. to the yard; they are laid on a concrete foundation, a strip of concrete 6 in. deep and 18 in. wide, composed of 5 to 1 Portland cement, being laid under each rail. Karri wood paving has been laid for a width of 1 ft. 10 in. on each side of the track, and a 9-in. toothing course along the inner side of each rail. The rail joints are each bonded with two 6/0 S.W.G. "Neptune" rail bonds. Special cast-steel points and crossings have been used.

The side arm system has been adopted for the overhead equipment, the trolley wire, of No. 0 S.W.G., being carried at a height of 18 ft. 6 in. above the rail level. The poles are of mild steel, tapering from 7 in. at the base to 3½ in. diameter at the top, and are furnished with ornamental base castings, finials and brackets. The arms vary in length from 6 ft. 6 in. to 15 ft., according to the width of the road, the average distance of the furthest trolley wire from the centre of the track being 10 ft. Owing to the tortuous character of the route, it has been found necessary to run the trolley wire partly on one side of the road and partly on the other to allow of the poles being fixed in the most suitable positions.

The generating station and car shed are situated at Camp's Bay, this site being the most suitable, owing to its proximity to the sea, from whence water is drawn for condensing purposes. Another reason lay in the fact that a continuous supply of fresh water for boiler feed purposes is obtainable from a small stream flowing down Table Mountain, and the position is fairly central.

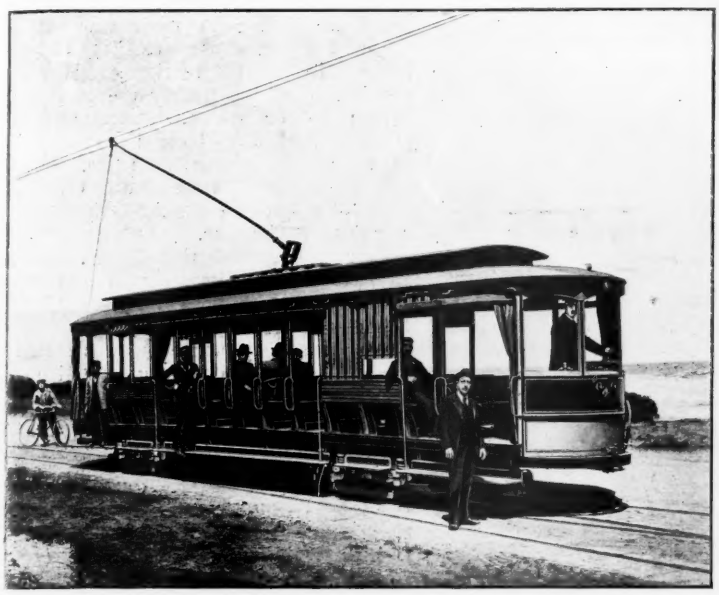
The engine room is 94 ft. × 42 ft., and consists of two floors and a condenser pit. A 10-ton overhead travelling crane arranged for hand power runs the whole length of the engine room, and has a lift of 16 ft. The boiler house is 94 ft. long × 43 ft. 5 in. wide. The car shed, which is also part of the same buildings, is 136 ft. long × 94 ft. wide, with eight lines of track, four of which have pits running their entire length. At the entrance to the car shed are offices, mess room and stores.



Generating Plant.

The generating plant consists of two direct coupled 400-kw. sets. The engines, constructed by Messrs. Yates and Thom, are of the cross compound type, developing 720 b.h.p. with a steam pressure of 150 lbs., when running

at 90 revolutions per minute. The main shafts are 19 in. diameter, and on these the generators and fly-wheels are keyed. The latter are 18 ft. in diameter, and weigh about



"Gridiron" Car.

24 tons each. The cylinders are fitted with Corliss automatic valve gear.

The generators were built at the works of the English Electric Manufacturing Company, Limited, Preston, and were subjected to severe tests by the engineers of the tramway company, Messrs. Alfred Dickinson & Co., Birmingham, who were highly satisfied with the way in which their specification had been met.

The output of each of the machines is 400 KW. at 550 volts; they are compound wound, are in accordance with the standard practice adopted at Preston, and are similar to those which Messrs. Dick, Kerr & Co. have supplied to many tramway and lighting authorities in the United Kingdom.

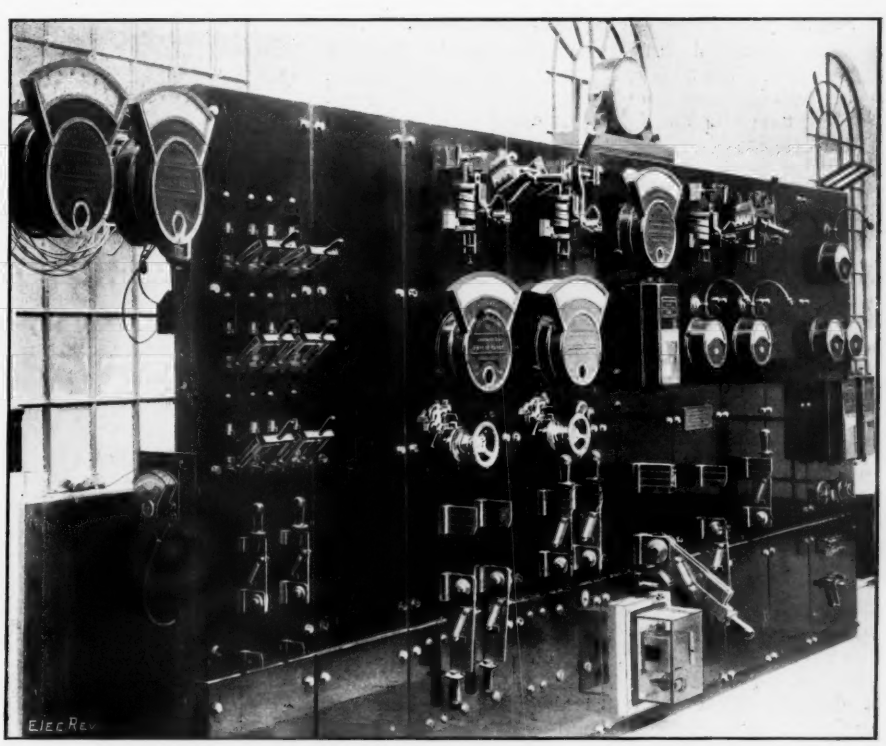
The field-magnet frame consists of high permeability cast-iron, into which are cast laminated steel pole-pieces. The armature is built up on a special form of spider, in which the sections of the rim are unconnected, thus avoiding shrinkage strains. The core is built up of steel laminations, spacing laminations being inserted to form ventilating ducts for cooling the interior of the core and the windings. The armature coils are laid in open slots on the periphery, and are interchangeable. The commutator is carried on its own ring, which is mounted on the extended hub of the armature spider. The commutator bars are of hard-drawn copper, and are firmly clamped by means of steel end rings. Equalising rings are attached to the commutator, and compensate for any slight variations in the magnetic reluctance of the various magnetic circuits, thus checking the slightest tendency to spark.

The switchboard consists of nine panels, of which three are generator panels, three feeder panels, one station panel, one lighting panel, and one leakage panel. Two of the generator panels only are in use, the other being a spare panel. Each is fitted with a positive and negative quick-break switch, capable of carrying 1,000 amperes, a magnetic circuit-breaker, and an ammeter reading from zero to 1,200 amperes. Two of the feeder panels are in use, the other being a spare. Each is fitted with an automatic circuit-breaker of the same type as those used on the generator panels, an ammeter reading up to 500 amperes, and a quick-break switch for connecting feeder to bus bar.

The main station panel is fitted with a main ammeter reading up to 3,000 amperes, on which the total output of the station is constantly shown, and a watt-hour meter. It is also fitted with a recording voltmeter, with a working pressure of 550 volts. The leakage panel contains all the instruments necessary for testing for leakage, &c. The lighting panel is arranged for six 50-ampere double-pole circuit switches, with fuses and throw-over switches.

In the condenser pit are two surface condensers with combined air and circulating pumps. These are of the Admiralty type, and are specially devised for using sea water. The cooling water is supplied to the condensers by means of large cast-iron pipes, which are carried well out beyond low-water mark. To avoid the danger of seaweed being drawn up into the condensers, the suction pipe has been interrupted on the shore by a sump built in concrete carried well down below low-water level, which is easily kept clear.

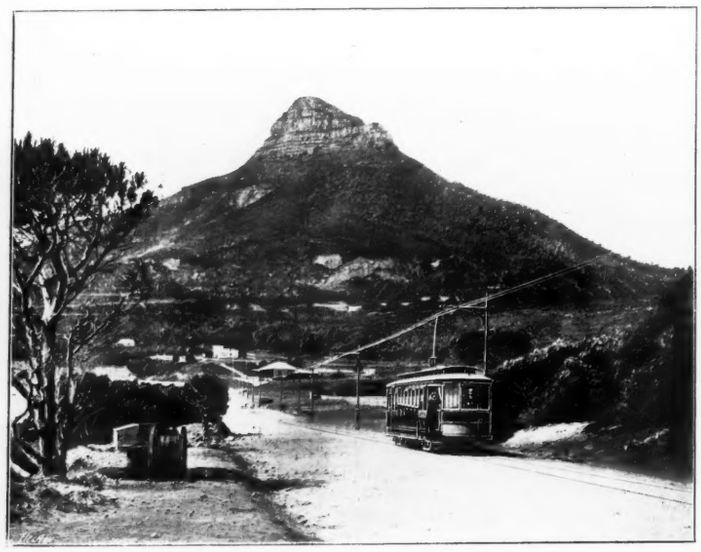
In the boiler house are two water-tube boilers, each with



Main Switchboard.

a heating surface of 3,654 sq. ft., and capable of evaporating 12,000 lbs. of water per hour under normal conditions. Each boiler is fitted with a dead-weight safety valve and a spring valve set to blow off at 160 lbs. pressure. The boilers are fed

by means of two compound non-condensing duplex feed pumps, capable of delivering 24,000 lbs. of water per hour against a boiler pressure of 160 lbs. per sq. inch. Before being pumped into the boilers the feed water is passed through a fuel economiser containing 288 pipes fixed in the main flue. The chimney stack is 125 ft. in height, and 5 ft. inside diameter at the top.



View of Tramway, and Lion's Head.

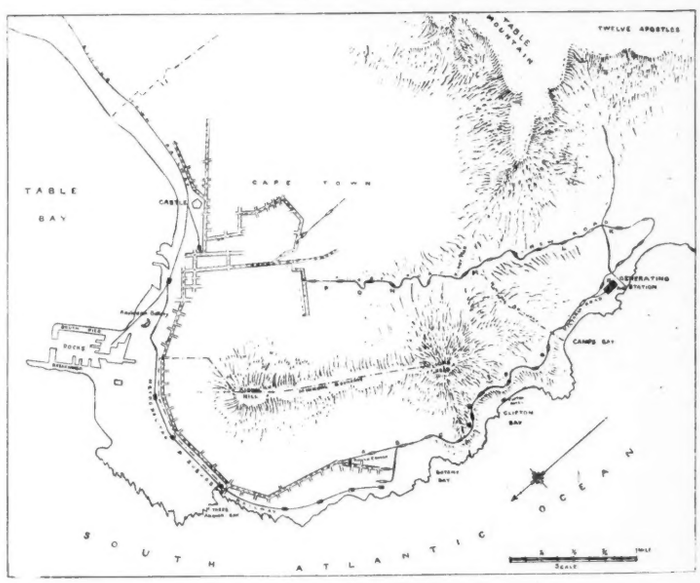
The works are equipped with the necessary machine tools for the purpose of carrying out repairs, including a large screw-cutting gap lathe, wheel lathe, wheel press, drilling machines, grindstone, smiths' hearth and fan, the whole being driven by an electric motor.

The feeder cables are laid in cast-iron troughs 18 in. below the surface, and are surrounded with bitumen. The conductors are insulated with paper and vulcanised rubber, and lead-covered. The main cables are laid in half-mile sections, and at each junction of two sections a feeder pillar is placed in which the cables are connected to a bus bar, and from thence to the trolley wires in the usual manner.

The cars are of special design to meet the prevailing climatic conditions of Cape Town. They are of single-deck bogie type; part are what are known as gridiron open cars, and part are of the combined type. The former have a seating capacity of 65 passengers, and the latter of 54. The length of car is 40 ft., width 7 ft. 6 in., and height inside 8 ft. They were built for Messrs. Dick, Kerr & Co., Limited, by the Electric Tramway Carriage Works, Preston, and shipped to Cape Town completely finished, the only work to be done before they could commence to run being to mount them on the trucks, connect the wiring and fix the trolley poles. In passing, it may be observed that so popular has Camp's Bay already become, that the company anticipate that the present equipment of cars will shortly be found too small to cope with the traffic. Each truck carries two motors, one on each axle. Here, it will be noticed, there is a departure from the usual lines; the equipment of the cars comprises four motors, each of 25 B.H.P., so that each car is capable of developing 100 B.H.P. There is hardly any question that four motor equipments with long cars are imperative where grades are heavy, and in the case of Camp's Bay the gradients are unusually severe. Not only, however, is a proper distribution of power necessary, but the question of braking and retardation is also of prime importance. The brakes, therefore, on these cars have received very careful consideration, three brakes having been fitted, viz., a hand brake with a brake block on each of the eight bogie wheels, an air brake acting in conjunction with the hand brake, and an auxiliary slipper brake. In addition to these, it is also possible, by throwing over the reversing switch, to convert the motors into generators, thus enabling them to act as a powerful emergency brake. The cars are operated from either end by means of a special controller designed for four-motor equipments.

It may be added that Messrs. Dick, Kerr & Co., Limited, carried out the work to the specifications of Messrs. Alfred Dickinson & Co.

The same firm, we may mention, successfully carried out the construction of the Barcelona and Madrid tramways, and the progress of this contract, curiously enough, was to some extent interfered with by the progress of the American-Spanish war. Another important Colonial tramway system which has been recently constructed by the company is that of Calcutta.



Map of Camp's Bay Tramways.

Calcium Carbide in Germany. — The amount of calcium carbide imported into Germany in the years 1899, 1900 and 1901, was 6,374, 7,703, and 9,506 metric tons respectively; the amount exported was 636, 224, and 274 tons. In the same years the German railways consumed in the manufacture of their acetylene-oil gas about 5,500, 6,000, and 6,500 tons; whence, making a reasonable allowance for the quantity of carbide made within the fiscal limits of the Empire, it has been calculated that 5,740, 6,980, and 7,250 metric tons were used in the years mentioned for purposes of domestic illumination in single generators, and in the 33 central installations which now exist in that country. These figures show a healthy, though slow, development of the acetylene branch of the industry; but they are nothing to what the carbide makers could turn out if there were a chance of selling their product. Thus it follows that before the manufacture of calcium carbide can become a more valuable employment for electro-chemical factories, the consumption of acetylene in such isolated districts as are unable to support electricity works, or as have already introduced coal gas works, must be stimulated by all fair means. This is to be done partly by the education of the public, chiefly by the different Acetylene Associations co-operatively suppressing the makers of badly-designed, awkward, complicated, or even dangerous generators.

BUSINESS NOTES.

(*Continued from page* 900.)

Catalogues, Lists, &c.—Messrs. J. E. Spagnoletti and Company, of Goldhawk Works, Goldhawk Road, W., have favoured us with copies of their price lists of motors and generators, and switches, switchboards and telegraph instruments. They are well illustrated and contain some interesting and useful information. We have also received a list of electric clocks and pamphlets describing their "Tolchard" patent battery regulator, and the "Rex" chemical fire extinguishers.

Pamphlet No. 124 has come to hand from the B.T.H. Co., describing their electric brake controllers, type B.

The General Electric Co. (1900), Ltd., send us a leaflet describing their Stanley-d'Arsonval moving-coil ammeters and voltmeters, batten lampholders, "Link" switches, paper-insulated bell wires, illumination globes, and new fixtures. Another leaflet describes their "Freezor" electric fans for direct and alternating current, for desks, brackets, ceilings, &c., and larger forms for ventilating rooms, &c.

Messrs. Crompton & Co., Ltd., have issued a pamphlet dealing with their "Coronation" arc lamps, for hire or purchase. These lamps give a golden yellow light, the whole of the globe being illuminated, and the mechanism is very simple. Arc projectors for illuminations are also described.

Mr. G. Braulik, of 217—218, Upper Thames Street, E.C., sends us a price list of his arc lamps, including miniature indoor lamps, taking from 1½ to 8 amperes, with suitable covers and reflectors; ordinary lamps for outdoor lighting, with a large variety of covers; inverted arc lamp reflectors; resistances, automatic cut-outs, &c.; shunt lamps; enclosed arc lamps; flame arc lamps; projectors; winches; concentric coupling; and a variety of other accessories.

We have received a price list of Messrs. John Spencer, Ltd.'s iron and steel tubes and fittings of all kinds, including telegraph, tramway, and arc lamp poles, and electric wiring tubes.

The Westminster Engineering Co., Ltd., send us a copy of their motor price list, comprising D.C. semi-enclosed and enclosed motors from ¼ to 40 B.H.P., and motor starters. They also send us leaflets describing the "Westminster" enclosed arc lamps.

A price list comes to hand from the Bergmann Electrical Works describing their Swan and Edison lampholders, magnetic lampholders (which can be attached to any object of iron or steel), watertight globes and sockets.

Messrs. J. Carter, Sons & Co. send us their price list of engineers' tools, comprising practically every class of appliance that an engineer requires.

The Langdon-Davies Electric Motor Company, Limited, have issued a new list of their single-phase alternate current motors, from ½ to 35 B.H.P., which it is claimed are self-starting without exceeding the normal full-load current.

We have received from Messrs. Fredk. Braby & Co., Limited, their new "Glasgow" illustrated catalogue of corrugated iron roofing sheets, galvanised iron tanks, &c. A special feature is the introduction of the "Barffing" process, by which iron articles are coated with a skin of magnetic oxide, entirely preventing oxidation—hence the name applied to the products, "rustless iron." A new plant has been laid down for carrying out this process on a large scale.

A beautifully illustrated little book (an abridged catalogue) comes to hand from Messrs. Alfred Herbert, Ltd., of Coventry, describing their machine tools, which comprise horizontal and vertical milling machines in great variety, cutter grinders, sensitive drills, capstan lathes, turret lathes, automatic screw and stud machines, slotting machines, saws, &c., and a vast number of accessories of all kinds.

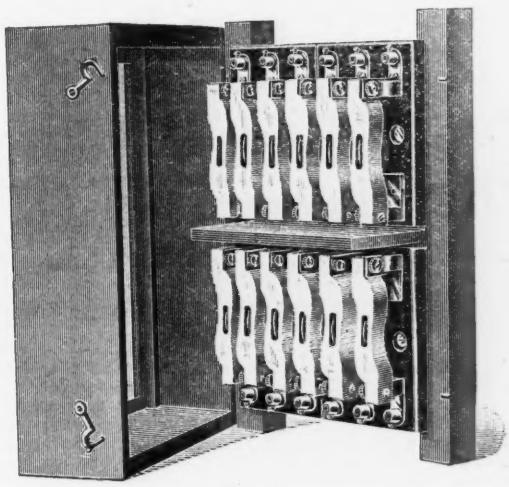
Condensing Plant.—Among other work that the Wheeler Condenser and Engineering Company have in hand at the present time, is the cooling tower and condensing plant for the Birmingham electric light station. The cooling tower has to deal with 90,000 gallons of water per hour. The company are also supplying for the East Ham electric light station a cooling tower and condensing plant, the cooling tower to deal with 45,000 gallons per hour. Both of the above are repeat orders. The Wheeler Company have also in hand a cooling tower plant for Messrs. Marshall, of Gainsborough, to deal with 35,000 gallons of circulating water per hour, and condensing plants for Sheffield, Stockport, and Erith electric light and power stations.

Coronation Note.—The directors of the Electrical Power Storage Company, Limited, have decided, in commemoration of the Coronation of King Edward VII., to pay their workmen a full day's pay for the Coronation day holiday, and to illuminate their premises at 4, Great Winchester Street.

Correction.—Referring to the electric lighting plant for Messrs. Gamage's, concerning which a note appeared in our last issue, we are asked to state that the whole of the contract, including boilers, engines, dynamos, &c, has been placed by Messrs. Gamage with Mr. A. H. Wood, of Victoria Street, S.W.

Rail Bonding.—A remarkably neat booklet has been issued by the Forest City Electric Co. dealing with this subject. The history of bonding is concisely outlined, with speaking illustrations showing various types of bonds and bonding methods, and the merits of the "protected rail bond"—a very excellent device in many ways—are clearly set forth. At the end of the book there is a capital set of tables for practical use in designing bonds, giving particulars of resistances of copper cables, energy lost in joints gauges and areas, interior contact surface of bond holes, &c.

Fuse for High Voltage.—The simple form of fuse shown in the following figures, in section, and as used in distribution boxes, has been introduced by Messrs. Richardson & Co., of Nelson Street, Stratford Road, Manchester. It will be seen that the fusible wire is enclosed in a porcelain block, which is provided with



an aperture in front through which the wire is visible; it is thus easy to see when the fuse has blown, while the narrow passages ensure an efficient blow-out. The terminal plates are slipped into spring contacts on the board, so as to be readily replaceable.

Trade Announcements.—Messrs. Heathman & Company, the ladder makers, have opened a South Kensington depôt at 351, Fulham Road, where they will keep a stock of ladders, steps, trestles and scaffolds for the use of electricians in the West End of London.

The Klein Engineering Company, Limited, inform us that Messrs. Harvey & Co., of 25, Victoria Street, Westminster, S.W., are now appointed their London representatives.

The Charing Cross and Strand Electricity Supply Corporation Limited, announce that their registered address and general offices are about to be removed to 60, St. Martin's Lane, W.C., where all communications should be addressed on and after 31st inst.

Mr. William M. Furniss, formerly with Messrs. Handley and Shanks, of Birmingham, has been appointed the representative of the Electric Construction Co., Ltd., in South Wales and District. Mr. Furniss's address, *pro tem.*, will be 70, Beauchamp Street, River Side, Cardiff.

The Brush Electrical Engineering Co., Ltd., inform us that they are removing their London offices to their previous address, Victoria Works, Belvedere Road, Lambeth, S.E., where all communications should be addressed after June 1st.

Owing to the increase of their business, Messrs. Gambrell Bros. have removed their office and works to more extensive premises at Durham House, 23, North Side, Clapham Common, London, S.W.

ELECTRIC LIGHT AND POWER NOTES.

Austria.—A company has been formed in Gratz to establish a large power station to utilise the water-power of the River Mur, about 18 miles from that town. The plant will have a capacity of about 3,000 H.P., and the electrical energy generated will be transmitted to Gratz and employed for power purposes in the many breweries and other industrial establishments there. The contract for the electrical plant has been placed with the Vereinigten Electricitäts Gesellschaft, of Vienna.

Blaenau Festiniog.—On 22nd inst. the electricity works was formally opened by Lord Newborough. The Yale

Electric Light Company, which is to supply the town, was formed two years ago for developing the water-power in this district. The slate quarries are to be supplied at 1d. per unit for power, and for public and private lighting 4d. will be charged. The company already has 400 H.P. in motors, and 3,000 8-C.P. lamps connected. Mr. T. P. O. Yale, is the managing director.

Bournemouth.—The T.C. has resolved to oppose the Bill to confirm the Pokesdown Electric Lighting Order, 1902, so far as the said Order is concerned.

Colchester.—About noon on Monday last week, the electric light service main in St. John's Street broke, owing to the heavy rains having caused a subsidence. The ground immediately became charged with electricity for the space of about five yards, and horses passing over the spot received "shocks." A large crowd assembled, and enjoyed what was evidently deemed fun. Mr. A. R. Sillar, the borough electrical engineer, was promptly informed of the mishap, and quickly took measures to rectify the breakdown.

Dalmatia.—La Societa Italiana del Carburo di Calcio is establishing large electro-chemical works at Sebenico, Dalmatia. In connection with this, a 7,000 H.P. plant is to be put down to utilise the water-power of the Kerka Falls, 6 miles from the works, in the generation of electrical energy. The contract for the turbines and electrical machinery has been secured by Messrs. Ganz and Co., of Buda-Pesth.

Derry.—The Corporation is about to give effect to a scheme of private electric lighting which has been in abeyance for almost two years. The streets are already electrically lighted.

Dudley.—Mr. E. A. Sandford Fawcett, on behalf of the Local Government Board, held an inquiry on Friday last week relative to the application of the T.C. for sanction to borrow £22,000 for electric lighting purposes. The Town Clerk stated that this was the third loan required on account of the electrical undertaking. In the first year of working, after paying principal and interest on the loans, there was a loss of £80. Last year there was a profit of £92. Mr. R. Wilson (borough electrical engineer) explained that the capacity of the power station was at present equal to 700 KW., and it was proposed to increase this by the addition of a 500-KW. engine and dynamo.

Dumfries.—Prof. Capper has visited the burgh in connection with the proposed lighting scheme. There is a probability of a tramway scheme also being adopted in connection with this.

Germany.—A central electric lighting and power station has lately been completed and put in operation at Anterturkheim. The water-power of the River Neckar is utilised, the plant comprising three 260-H.P. Voith turbines and dynamos, and two 250-H.P. steam dynamos.

Huddersfield.—The Electricity Committee of the Corporation has received the sanction of the L.G.B to borrow the sum of £99,483 for purposes of electric lighting (extensions), &c., and the County Borough Council at its meeting on 21st inst. resolved to make application to the B. of T. for a prov. order for power to supply electricity within the area of Milnsbridge and within the districts of Golcar and Linthwaite (outside townships). The Electricity Committee also decided to grant electricity free for purposes of decoration on June 26th, 27th and 28th, in honour of the King's Coronation.

Hull.—At the meeting of the E.L. Committee of the Corporation on 21st inst., the chairman said the past year had been one of considerable activity, and their authorised capital amounted to £244,032. They had now 1,843 consumers connected, and sold 1,490,099 units, being an increase of 183,024 over the previous year. Owing to an increase in the working expenses he regretted that there was a deficit of £2,732 on the year's working.

Hythe.—At length the Folkestone Electricity Supply Company has obtained wayleave through Sandgate to Hythe, and in order to obtain electric light as early as possible, the Hythe T.C. has decided to ask the company to pay to its credit the value of the Corporation's prov. order, which lapses on July 30th.

Kingston-upon-Thames.—The annual report of the electricity undertaking, ending March 31st last, shows that there is a deficit of £2,295 as against £2,721 during the previous year.

London.—WESTMINSTER.—About three o'clock on 17th inst. the underground cables under Cranborne Street were found to be on fire outside Daly's Theatre. Several slabs of the pavement were blown up, but fortunately no one was injured.

STEPNEY.—The arbitration between the County of London and Brush Provincial Electric Lighting Company and three of the districts comprising the Stepney Borough, which obtained provisional orders, has at last been settled. The company claimed a sum of £22,000 for the extinction of their rights. As the result of the hearing the arbitrator has ordered the payment of a sum of £5,000 to the company. This is to be levied on the three parishes and districts named, the fourth district, Whitechapel, having previously had the enterprise to instal its own municipal system.

ISLINGTON.—The M.B.C. electricity department has now laid cables along the whole length of Hornsey Road, and the Council has passed estimates for low-pressure extension cables for private lighting only, amounting to a total of £7,130. An estimate was also passed for mains for private supply and public lighting at a cost of £3,900, and for minor extensions at a cost of £772.

Manchester.—The electric cables fused on Monday last week in Hall Street. Considerable damage was done to the cables; the bitumen and covering were burning for over half an hour.

Paisley.—The T.C. has resolved to lay down extra plant at the electricity works at an estimated cost of £8,500. Of this, £2,000 will be required for the tramway scheme.

Paris.—According to the *Sun*, the policemen on night duty are to have electric lights on their uniforms and at the extremities of their batons; these will be used in the regulation of the street traffic.

Renfrew.—Messrs. Babcock & Wilcox, Ltd., of Renfrew, have recently adopted electric power throughout their works. A large power house has been erected containing engines aggregating 1,200 H.P. The power generated is distributed to motors arranged on the group system and worked at a pressure of 220 volts.

Southampton.—The Corporation has received the sanction of the L.G.B. to construct the new electric light works on the western shore, and work will at once be proceeded with.

Spain.—Application has been made to the authorities of the province of Almeria to put down plant to utilise the water-power of the Rivers Nacimiento and Andarax in the generation of electrical energy for lighting and power purposes.

Stafford.—At the T.C. meeting last week, it was stated that there was a charge on the rates for the electricity department of £1,100.

Stoke-on-Trent.—The T.C. has decided to oppose the proposed application by a syndicate for powers to erect electric generating stations and lay mains for the supply of electricity in Cheshire and the northern portion of Staffordshire.

Sudbury.—A L.G.B. inquiry was held on 22nd inst. into the application of the Corporation to borrow £12,000 for electric lighting purposes.

ELECTRIC TRACTION NOTES.

Aberdare.—The British Electric Traction Company, Limited, have notified the D.C. that they have under consideration a proposal to promote next Parliamentary session a tramway scheme for this large area; but before incurring any preliminary expenses (necessarily heavy), the company inquire whether the Council will favour the scheme, provided an agreement is come to as to details, and an interview is suggested. The whole question of electric tramways will be dealt with at the next Council meeting.

Birkenhead.—The Tidswell type of life-guard has had an opportunity of proving its efficiency in connection with the Birkenhead electric tramways. On Wednesday last week, when a bogie car on the Ferry—Prenton route was turning into Atherton Street, a girl of four years, named Murphy, ran on the track and fell as the car was approaching. The gate of the Tidswell guard struck the child, and the guard at once dropped to the track, caught up the child, and carried it safely until the car came to a standstill. On examination, the child was found to be uninjured beyond some slight bruises, which were supposed to have been caused by contact with the gate.

Bournemouth.—The B. of T. has declined to grant the Council's application, which formed the subject of an inquiry in London recently, to construct a tramway in the Parkwood Road, Pokesdown. The T.C. has resolved to apply to the B. of T. to extend the time for completing the tramways and the works in connection therewith.

Cardiff.—The reconstruction work has now been completed, and that six weeks before the stipulated time. Fares have been re-arranged, and an indemnity fund against accidents established under Corporation auspices. The cars were run on Sunday for the first time. Only 12 employés objected to Sunday labour, against 161 affirmatives. Over 100,000 passengers were carried in the new electric cars at Cardiff on Whit Monday.

Chatham.—The handsome electric tramcars of the Chatham and District Light Railways Company for the past three days have been running in order to test the working of the system. On Monday the B. of T. officials were to inspect the tramways and the cars, and it was hoped that all the trams would be running by the end of the week. The generating station and car-sheds have been erected at Luton, just outside the High Street of Chatham.

Dudley.—On Wednesday evening one of the guard wires connected with the tramway in High Street snapped and fell across the trolley wire, a considerable length of the broken strand being extended along the street. The contact with the trolley wire caused the broken guard-wire to become "alive," and wherever it touched the rails sparks were emitted, plainly indicating its condition. As a consequence the greatest consternation was caused among the pedestrians and tradesfolk. As the cars were not equipped with gloves or pliers, before the wire could be removed there had been a complete block in the tram service, and a partial block in the street traffic, lasting three-quarters of an hour.

Durban.—The first section of the electric tram service was recently opened. The overhead trolley plan is adopted, and centre poles are principally used.

Glasgow.—The Corporation has under consideration at present extensions to Clydebank in the west and Kirkintilloch in the north. The former burgh is anxious that Glasgow should work the tramway system in conjunction with the Glasgow system for a term of years, at the end of which the burgh would take over the plant within the burgh as its own. Nothing definite has been settled yet, and companies are doing their best to get into these suburban burghs. An engineering difficulty presents itself in both cases, viz., the bridging over the Forth and Clyde Canal. At present the old-fashioned bridges require to be raised and lowered to allow barges to pass, in much the same manner as the Tower Bridge.

Gloucester.—The City Council has decided to apply to the Light Railway Commissioners for permission to construct a light railway in its own district and to some of the surrounding districts, and consequently there appears to be no possibility now of settling the dispute with Mr. Nevins as to certain roads which come under the jurisdiction of the County Council, and over which he desires to construct his network of electric tramways. The County Council also further considered the matter at a special meeting held on Saturday last, and decided not to agree to the proposals of the Corporation. It will be interesting to see how this dispute will terminate, but, unless an amicable arrangement can be arrived at, the introduction of electric traction into a very wide and populous area of Gloucestershire must be seriously hampered, if not prevented altogether.

Hastings.—The Corporation has decided to consent to the Hastings Front Line Electric Tramways Bill, on certain conditions as to the prior completion of the lines to the out-bounds already authorised by Act of Parliament. The resolution passed on March 7th, declining to entertain the application of the promoters, had previously been rescinded by the Council. The Bill will be opposed before the Parliamentary Committee by frontagers and other residents.

Leeds.—An electric car, laden with passengers, was on Sunday afternoon proceeding from Stanningley to Leeds, when, on taking a curve near Castleton Bridge, it travelled 70 ft. on the stone sets, rushed over the causeway, and crashed into the bridge, and 17 passengers were injured or shaken. It appears that the brake did not act, and it is to be subjected to exhaustive tests.

Leicestershire.—Application has been made by Lieut.-Colonel R. E. B. Crompton for powers to construct light railways in the county.

Liverpool. — There was a slight outbreak of fire last Monday at the Dingle Station, on the Liverpool Overhead Electric Railway. A train, consisting of three carriages, was standing at the platform, when a flame issued from the motor box, and the woodwork around caught fire. An alarm was at once given, and the station officials were quickly on the scene with a hose and hydrants, the flames being extinguished before much damage was done.

In a letter to the local press, the chief engineer, Mr. S. B. Cottrell, stated that neither the station nor the carriages composing the train caught fire; one of the magnets fused; the electric current was at once cut off, and the burning cable extinguished by the station staff with little or no damage. The whole occurrence only occupied a very few minutes, and caused practically no dislocation of the service. The promptitude with which the outbreak was dealt with showed the efficiency of the arrangements made at the station for extinguishing fire, after the accident last Christmas.

London.—According to present anticipations, the section of the Great Northern and City Railway from Moorgate Street to Drayton Park will be ready for traffic shortly after the Coronation.

Middlesex.—Application has been made to the Light Railway Commissioners by the County Council for authority to construct further light railways in Middlesex.

Mountain Ash.—The D.C. for this large Glamorganshire centre has decided not to entertain the proposals of the British Electric Traction Co. to lay tramways in the district.

Paris—Versailles.—This new line is to be inaugurated on June 1st. Trials made last week have given satisfactory results, and the trains did the journey in 50 minutes. It is, however, hoped later to run an express service capable of performing the journey in 15 minutes.

St. Helens.—Last week the daughter of Henry Higham, a girl aged seven years, was knocked down by an electric car in North Road, St. Helens. The driver pulled up, and the girl was found under the life guard. It was found that her skull was fractured, and that she had sustained other injuries. Mr. Higham and family were to have emigrated to America in a few days.

Slough.—The London United Tramways Co. gave official notice at Slough on Saturday last, that they intend to apply to the Light Railway Commissioners this month for power to extend their system of electric tramways to Colnbrook, Slough and Maidenhead.

Southport.—A new electric tram line is to be constructed in Cemetery Road and Shakespeare Street, Southport, as soon as the provisional order is received. The new line will cost about £7,500, which will cover everything except the cost of the cars. The total length of the line will be less than 1½ miles.

Spain.—A proposal is under consideration to convert the steam railway between Bilbao and Las Arenas into an electrical line. La Compania Hidro-Electrica Iberica is reported to have offered to supply the necessary electrical energy on advantageous terms.

Stroud.—Application has been made by Mr. T. Nevins for leave to construct light railways near Stroud in the County of Gloucester. The County Council has also applied for powers to a similar end.

Sweden.—The Faluen-Westerdalelf Railway proposes to carry out some experiments with electric traction on a part of its line, with a view to its adoption on the whole system.

Wolverhampton.—During the past week the Tramways Committee were able to run a much better service, as the number of cars was nearly doubled; but even now there is a difficulty in coping with the number of passengers. There has been a number of slight accidents. One day last week a horse received an electric shock while passing up Waterloo Road. The animal is now useless, and the town clerk has received intimation of intended legal proceedings. On Saturday night a horse worth £50 was killed in Piper's Row. It is asserted that this was the result of an electric shock, and the matter is now in the hands of the veterinary surgeons and the legal gentlemen. On Saturday morning two horses and two drivers connected with the Great Western Railway Co. were proceeding in the direction of Bilston Road, when the horses began to plunge violently and fell forward, and the men had to get off the wagon to attend to them. The result was that both men received shocks and were attended to at the General Hospital, but in neither case was the result serious. The horses, however, were said to be much bruised by tumbling about. Both men declare that there was nothing about the Lorain box to call their attention to it before the shock to the horses. Again, on Monday morning, another accident occurred on the Bilston Road. While a carter named Griffiths was driving a load of slack along the road the horse suddenly fell down, and the man Griffiths himself stepped on a box and received a shock. These accidents point conclusively to the fact that the boxes must occasionally be left "alive." Meanwhile the electrical equipment of the Tettenhall line is being rapidly pushed forward, and in the course of about another week the line will be electrically equipped.

TELEGRAPH AND TELEPHONE NOTES.

Bismarcksburg.—Telegrams can now be sent to Bismarcksburg, in German East Africa, at the rate of 3s. 7d. per word.

Charleroi—Marseilles Telephone.—We learn that Charleroi will shortly be in telephonic communication with Paris and Marseilles. Trials that have just been made between Thuin and Brussels, Charleroi, Paris and Marseilles have proved successful, and conversations were carried on very clearly. This will probably be one of the longest telephone lines in Europe—the distance between Charleroi and Marseilles being 1,200 kilometres.

Glasgow.—A remarkable feat has been accomplished by the National Telephone Company in connection with the work of fitting up the new south-side exchange. As the result of the serious fire on Tuesday last week, the switch-room and test-room were entirely gutted, and the outside wires considerably damaged. Six new sections of switchboards, which were ordered from the company's factory, arrived in Glasgow on the morning following the fire, and these were fitted up in temporary premises adjoining the old exchange. The cables and outside wires had to be completely renewed near the exchange. Intimation had been made to the subscribers who were affected by the fire that communication would be partially opened by Monday morning; the company have improved upon this by establishing a record in telephone exchange building. By mid-day on Friday—three days from the time the fire began—communication was opened with 50 subscribers, an additional number have since been connected up, and the whole exchange is now practically complete. The company are entering into negotiations for larger and more commodious switch-rooms than those which were destroyed, for their permanent plant.

Muscat.—The rate for telegrams to Muscat by the route of the Indo-European Telegraph Company has been reduced to 2s. 3d. per word.

Reduction of Rates to Australasia. — The Eastern Extension, Australasia and China Telegraph Company, notifies that the cable rates on and after June 1st, will be reduced as follows:—New Zealand, 3s. 4d.; New Caledonia, 3s. 8d.; Norfolk Island, 3s. 2d.; and Fiji, 3s. 7d. per word.

Swansea.—There are 398 acceptances of Corporation telephonic rentals, and another 117 notify readiness to support. The Postmaster-General suggests £4 as a minimum, but the Corporation desires £5 as the tariff.

Wireless Telegraphy.—Prof. Fessenden has been experimenting for two years, under the auspices of the U.S. weather bureau, with a new device for receiving wireless telegrams, which he considers better than a coherer. The experiments have been made between Roanoke Is. and Hatteras Inlet, a distance of more than 50 miles. The speed of signalling attained is stated to be equivalent to over 500 words a minute.

Wireless telegraphy is said to be successfully established in the Hawaiian Isles. Inter-island rates vary from 2s. to 8s. for 10 words, exclusive of address. No cables are in use in the group.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barking.—June 6th. Motors, pipework, chequer plating, &c. See "Official Notices" May 9th.

Beckenham.—June 6th. The U.D.C. wants tenders for incandescent lamps. See "Official Notices" May 16th.

Bermondsey.—June 16th. Main switches, cut-outs, distributing boards, electrical fittings, shades, conduits, &c. See "Official Notices" to-day.

Brighton.—June 9th. Points, crossings, tie-bars, bolts, &c., for the Corporation tramways; also 300 tons of steel rails. See "Official Notices" May 9th.

Brighton.—June 9th. Supply of 300 tons of steel girder tram-rails. Particulars from Mr. T. B. Holliday, Lewes Road, Brighton.

Burton-on-Trent. — May 30th. Tenders for three 100-KW. tramway generators, switchboard, three Lancashire boilers, steam pipes, jet condensing plant, economiser, &c. See "Official Notices" May 16th.

Bury.—June 24th. Construction of permanent way for tramways. Particulars from Mr. A. W. Bradley, borough engineer and surveyor.

Copenhagen.—June 6th. The Danish Telegraph Department wants tenders for the supply of 78,000 kilos. of copper wire, and about 10,000 kilos. of steel wire.

Dudley.—June 6th. Tenders for the supply of incandescent lamps, and oil. See "Official Notices" May 16th.

Eastbourne.—June 6th. One dry-back marine type boiler and fittings. See "Official Notices" May 23rd.

France.—June 8th. The municipal authorities of Pradelles (Haute Loire) are inviting tenders for the establishment of a central electric lighting station in the town. Particulars may be obtained from, and tenders are to be sent to, La Mairie de Pradelles (Haute Loire).

Fulham.—June 5th. Tenders for pipework. See "Official Notices" May 23rd.

Glamorgan.—May 31st. Electric wiring, &c., for Parc Gwyllt and Angelton Asylums, near Bridgend. See "Official Notices" May 9th.

Glasgow.—June 7th. Economiser and condensing plants. See "Official Notices" May 9th.

Glasgow.—June 7th. Supply of electricity meters for one year. See "Official Notices" to-day.

Greenock.—June 2nd. Tenders for 300-KW. steam dynamo, with piping. See "Official Notices" May 23rd.

Hoylake and W. Kirby.—June 9th. Tenders for electric lamps, oil, waste, &c., for 12 months. See "Official Notices" May 23rd

Hungary. — September 1st. The authorities of Kolozsvár, in Hungary, want to introduce electricity for lighting and power purposes. See "Official Notices" May 9th.

Hunslet.—June 3rd. Tenders for two electric lifts. See "Official Notices" May 16th.

Kirkcaldy.—June 21st. Wiring of electricity works. Specification, &c., from Messrs. Kennedy & Jenkin, 17, Victoria Street, London, S.W.

Launceston (TASMANIA).—September 15th. The Corporation wants tenders for polyphase generating, transmitting, transforming and distributing apparatus, reconstructing existing plant, enclosed arc lamps, &c. See "Official Notices" May 23rd.

L.C.C.—June 5th. Wiring and fittings for four fire stations at Battersea and Camberwell. See "Official Notices" May 23rd.

London, S.W.—July 31st. The War Office wants tenders for a self-propelled lorry (oil). See "Official Notices" April 25th.

Nuneaton.—June 18th. One water-tube boiler and connecting pipework. See "Official Notices" to-day.

North-Eastern Railway. — June 9th. Telegraph apparatus and telegraph wire and line stores. Further particulars from Mr. Graves, Telegraph Department, York.

Rotherham.—June 17th. Tramway and lighting feeders, mains, &c., Lancashire boilers, and steam dynamo. See "Official Notices" to-day.

Roumania.—June 13th. Tenders are being invited until June 13th by the municipal authorities of Calarashi—Stirbeiu for the concession for the electric lighting of the town during a period of 35 years.

Russia.—The Ouprava Company, Saratoff, Russia, asks for offers for a central power station for the production of electrical energy for public and private lighting, traction and motive power purposes.

Sophia.—June 9th. The Bulgarian Posts and Telegraphs Department wants tenders for the supply of telegraphic and telephonic apparatus.

Stockton-on-Tees.—June 10th. Boilers, condensing plant, steam dynamo, switchboard, mains, &c. See "Official Notices" to-day.

Stretford.—June 18th. Tenders wanted for boilers, superheaters and economisers, steam dynamos, condensers, pumps and mains. See "Official Notices" May 23rd.

Tonbridge (Kent).—June 9th. Wiring electricity works. Particulars from Mr. R. Hammond, 64, Victoria Street, London, S.W.

Warrington.—June 18th. Tramcars, with electrical equipments. See "Official Notices" to-day.

CLOSED.

Barnsley.—The Corporation has accepted the tender of the Electrical Power Storage Company, Limited, for the supply of a storage battery.

Bexley Heath.—According to the *Contract Journal* the T.C. has accepted the following tenders:—A. Penny & Co., tramway rails and fishplates; W. Scott & Co., anchor plates; Dick, Kerr and Co., bolts, nuts and tie bars.

Bournemouth.—The T.C. has accepted the estimate of Messrs. J. G. White & Co. (£1,849) for track-laying in connection with the car shed, and Messrs. Jenkins & Sons' estimate of £550 for the construction of a cooling tank.

Bristol.—Messrs. Siemens Bros. & Co., Limited, have received an order from the Corporation for a turbo-generator to be erected at Temple Back station.

Broughty Ferry.—The contract for the supply of a storage battery has been placed with the Electrical Power Storage Company, Limited, by the Town Council.

East Sussex.—We are informed by Messrs. J. E. Spagnoletti & Co. that whereas last week we stated that the amount of their tender for East Sussex County Asylum was £1,773 11s, we should have said £11,773 11s.

France.—The French Post and Telegraph authorities in Paris have just given out contracts as follows:—La Compagnie Française des Métaux, Paris, 100 tons of high-conductivity copper wire 2½ mm. diameter, and 50 tons ditto. 3 mm. diameter; La Compagnie des Trefileries du Havre, Paris, 150 tons ditto. 2½ mm. diameter; M. Grammont, of Pont de Cherux, 100 tons ditto. 2½ mm. diameter, and 50 tons ditto. 3 mm. diameter; La Compagnie Générale d'Electricité, Paris, 50 tons ditto. 2½ mm. diameter; and La Compagnie Française du Bi-metal, Paris, 50 tons ditto. 4 mm. diameter.

Hamilton.—According to the *Contract Journal*, Messrs. Edmundson and Co. have secured the contract for the erection of the new electricity works at Almeda Hill.

Mansfield.—The T.C. has accepted the tender of Messrs. Crompton & Co., Limited, for Section "L"—pipework, valves and tanks—in the sum of £2,486.

Whitby.—The U.D.C. has accepted the tender of the Reason Manufacturing Company for 100 electricity meters.

FORTHCOMING EVENTS.

Friday, May 30th.—At 9 p.m. Royal Institution. Signor G. Marconi having fallen ill, the evening discourse will be delivered by Dr. J. A. Fleming, on "The Electronic Theory of Electricity."

Thursday, June 5th.—At 8.30 p.m. Röntgen Society, meeting at 20, Hanover Square. The President, Mr. Herbert Jackson, will read a paper on "The Sources of Phosphorescence."

Friday, June 13th.—At 3.30 p.m. Physical Society. Meeting at the National Physical Laboratory, Bushy House, Teddington.

SOME NEW ALUMINIUM ALLOYS.

Aluminium-Tungsten.—L. Guillet has recently published a preliminary account of some experiments on the preparation of a binary alloy of aluminium and tungsten by means of the Goldschmidt process. The aluminium was mixed with tungstic anhydride, and ignited with a mixture of aluminium powder and barium peroxide. Three alloys were obtained: (1) a body having the composition AlW_2, which is slightly attacked by strong acids, and decomposed by boiling water; (2) an alloy consisting of Al_5W, having the same properties as the preceding one; and (3) Al_4W, which is easily attacked by strong acids or boiling water, and appears as lamellar crystals. Michel has already described the alloy Al_4W as an iron-grey brittle crystalline powder from which hot caustic soda dissolves all the aluminium, leaving pure tungsten. This alloy had the specific gravity 5·58. An alloy containing 7·5 per cent. of tungsten has also been examined mechanically, and has given tensile strengths of from 10 to 16 tons per sq. in., with elongations ranging between 1·5 and 14·0 per cent., according to whether it was cast, hard-rolled, or annealed.

It may be remembered that two ternary "light" aluminium alloys containing tungsten have been on the markets for several years, and have proved to possess valuable qualities. One of them, called "wolframinium," contains 98 per cent. of commercial aluminium, with 1 per cent. of tungsten and 1 per cent. of copper as the third constituent. Its specific gravity is 2·74, essentially the same as that of pure aluminium itself. Its tensile strength, cast in sand, is 10 tons per sq. in.; cast in iron chills, 12 to 13 tons; forged, 15 tons; rolled or drawn, 20 to 22 tons per sq. in. Before annealing its elongation is 3 to 5 per cent., after annealing 12 to 20 per cent. It takes a high polish, and does not tarnish in the air. The second alloy, called "romanium," contains 1 per cent. of tungsten and 1 per cent. of nickel as the third ingredient. Its specific gravity is 2·75. Its tensile strength is about the same as that of wolframinium in whatever physical condition it be examined; but it is harder and of greater elasticity. It can be worked either hot or cold, and is more easily machined than pure Héroult aluminium; it can also be forged, rolled, drawn, and stamped. According to the patent specification (No. 21,186, 1895), romanium is made by adding amorphous tungsten to molten nickel, and then introducing the aluminium. Or, an alloy of tungsten and aluminium is prepared by melting the latter metal with a mixture of tungstic anhydride and cryolite, so as to produce a substance containing 10 per cent. of tungsten. More aluminium is then added in sufficient quantity to bring the proportion of that constituent in the finished alloy up to the desired amount, and the whole is poured into the molten nickel. Romanium is specially interesting just now, as one of the leading cycle companies has announced that it is about to build its machines with romanium rims, which will have the advantage over the nickel-plated steel rims hitherto adopted of not becoming rusty and unsightly when the rim brakes rub off the superficial layer of metal.

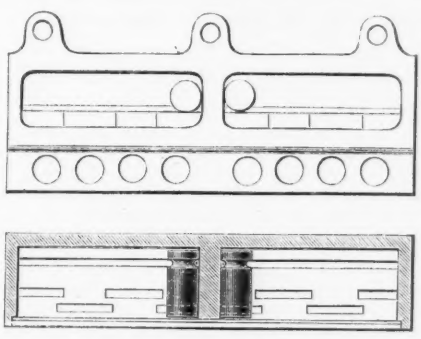
Aluminium-Molybdenum.—Guillet has also investigated the binary alloys of aluminium with molybdenum, preparing them by reducing molybdic acid with excess of aluminium in the same fashion as he did in the case of the tungsten alloys. He has obtained at least six definite alloys: Al_7Mo, Al_3Mo, Al_2Mo, $AlMo$, $AlMo_4$, and $AlMo_{20}$. All of them are attacked by strong acids; none by boiling water; some of them resist the action of dilute hydrochloric acid, *e.g.*, $AlMo_4$ and $AlMo_{20}$. Wöhler prepared an alloy to which he gave the formula Al_4Mo, describing it as a black crystalline powder consisting of iron-grey rhombic prisms, soluble in hot nitric and hydrochloric acid. Guillet mentions the same Al_4Mo alloy as yielding lamellar crystals.

Aluminium-Antimony.—Lippmann has been examining that curious alloy of aluminium and antimony having the composition AlSb, which was apparently first described by Alder Wright in 1892 and subsequently by Roche in 1893. This substance melts at between 1,078° and 1,080° C. (Wright said above 1,000° C.), whereas its constituents melt at 660° and 630° C. respectively; and it is therefore an exception to the rule that alloys generally are more fusible than their ingredients separately. Lippmann found the specific gravity of the substance AlSb at 4° — 16° C. in vacuo to be 4·2176, the gravities of aluminium and antimony being 2·67 and 6·72 respectively. By calculation it should have had a density of 5·2246; so that a considerable increase in volume must occur during its production, and it forms an exception to Matthiessen's law. Both Wright and Roche state that AlSb disintegrates in moist air, and liberates hydrogen from water; in fact, none of the aluminium-antimony alloys appear to be permanent. Roche claimed that an alloy containing less than 5 per cent. of antimony would be useful in the arts; but it has also proved to fall to pieces after a few months' exposure to the atmosphere. He recommended the use of such substances for the production of ternary alloys with copper or nickel, asserting that materials of great hardness, strength, and elasticity could be prepared in that fashion. We do not know whether his idea has proved to be correct or not; nothing would seem to have been published respecting the actual properties of ternary alloys of aluminium containing antimony, excepting that in one of Mach's subsidiary patents covering the manufacture of "magnalium," an addition of 10 or 15 per cent. of antimony is stated to have the advantage of raising the melting point of that alloy from 700° C. to a white heat.

Aluminium-Magnesium.—Boudouard has recently determined the melting points of a long series of aluminium-magnesium alloys, of which "magnalium" is the best known type. He finds that the curve of the melting points exhibits two maxima, at $AlMg_2$ and AlMg respectively; also 3 minima. Magnalium itself still continues to be much written about, but little fresh information is given. Kaempfer has stated that the alloy turns well, can be drilled or milled readily, and does not clog the finest files. It is harder than pure aluminium, and cannot be cut with a knife. Its tensile strength is from 13 to 15 tons per sq. in. It takes and retains a high polish. Its specific gravity is 2·52 ± 0·03. Its fracture has a fine grain, like that of steel. Siemens & Halske, of Berlin, are reported to be using it in the manufacture of armatures and for motor car parts; otherwise it would seem to have been taken up mainly by opticians, as its extra hardness in comparison with pure commercial aluminium causes the threads chased on lens mounts of magnalium to stand wear and tear better than usual. The claim that magnalium can be soldered satisfactorily is always being insisted upon very strongly; although no reference is made to the difficulty—not of merely uniting two pieces for a few minutes by the aid of the bit, which is undoubtedly small—but of making some kind of soft solder sufficiently electro-positive in character not to form a galvanic couple of serious voltage with the magnalium itself when the article is exposed to damp air.

NOTES.

Walker's Equilibrium Regulator.—Mr. Fredk. Walker, of Oxford, has designed an automatic and anticipatory equilibrium regulator for preserving the stability of electrically-driven air-ships. This regulator is shown in front elevation and section below. It consists of an insulating case divided into two compartments, each having a heavy bronze roller, rolling by gravity over contact surfaces. The back strips are connected to the main lead, and are higher than the other strips, so as to engage with an annular groove in each roller to guide it. The other strips are connected to the terminals of a rheostat, which is cut out of both branch motor circuits when the air-ship is level transversely. The twin screw-propellers rotate under triple aërocurves, and the



action of the regulator is to diminish the speed of the motor on the lowest side by putting resistance in. The longitudinal equilibrium is controlled by a similar regulator set fore and aft; this acts by reversing a small electro-motor, which alters the angle of a long tube centrally pivotted, containing about 60 lbs. of mercury. This regulator is specially designed for the new air-ship *Specia*, which is being built to the order of M. Panuzzi, and is the second British air-ship in construction, and the first to be driven by electricity. The power plant is designed by Mr. Fredk. Walker.

Obituary.—The death occurred on Saturday last of Captain Abel Henry Chapman, chairman-director of Messrs. Clarke, Chapman & Co., Limited, Gateshead. Captain Chapman was born at Wanstead in 1836, and, although of Quaker parentage, joined the Army in 1856, obtaining a commission in the 1st Regiment Bengal Cavalry. He retired from the Army in 1874. The death of the late Mr. W. Clarke in 1890 threw a great deal of responsibility on Captain Chapman, particularly in the commercial and financial departments of the business, which has been greatly increased.

The Electrical Standardising, Testing and Training Institution.—Prof. C. A. Carus-Wilson, M.A., M.I.E.E., commenced a special course of lectures to the senior students of the above Institution, upon "Dynamo, Motor and Transformer Construction," on Monday last, May 26th.

Coronation Illuminations.—Mr. A. E. Farrow, of the Windsor Electrical Installation Company, says that no special arrangements are being made, nor will there be any reduction in price, but the Town Hall is to be electrically illuminated and the work carried out by the company.

Institution of Junior Engineers.—A large party of members of this Institution recently paid a visit to the Great Eastern Railway Works, at Stratford, by the courtesy of the locomotive superintendent, Mr. J. Holden, M.Inst.C.E. On Monday next there will be a visit to the new signal cabin of the South-Eastern and Chatham Railway.

Institution of Electrical Engineers. — The report of the Council, presented to the meeting on 22nd inst., announces an increase of membership of no less than 538. Premiums were awarded to Messrs. O. Lasche, H. W. Clothier, S. G. Brown, Frith and Lamb, H. M. Hobart, K. A. Scott-Moncrieff, D. Robertson, and A. Russell, for papers and communications. The Salomons Scholarship, value £50, has been awarded to Mr. P. A. Laubach, and the Hughes Scholarship, value £50, to Mr. E. Fisher, both of the Finsbury Technical College. Sectional Committees have been appointed representing the following interests respectively:—(1) Traction, light, and power distribution; (2) telegraphs and telephones; (3) manufacturing; (4) electro-chemistry and electro-metallurgy. The accounts show a surplus of £758 2s. on the year's work, and the building fund now amounts to £10,000.

Special Committees are dealing with questions of importance to the industry, and the new wiring rules will, it is hoped, be issued during the summer. A visit to Northern Italy is to take place in the spring of next year.

The President of the Board of Trade will receive a deputation from the Institution on Thursday next on the subject of the disabilities imposed on the industry by adverse legislation.

DUBLIN SECTION.—The following officers have been appointed for the session 1902—3:—Chairman, J. W. Towle; vice-chairman, A. E. Porte. Prof. W. F. Barrett, F.R.S., G. F. Pilditch, P. S. Sheardown, F. Gill, W. Tatlow, M.A., B.E., H. Luttrel-Elward, W. Brew, W. Brown, B.Sc., A. T. Kinsey, Prof. W. E. Thrift, M.A., F.T.C.D. The last meeting of the session was held at the Royal College of Science yesterday, when a paper on "The Lighting and Driving of Textile Mills by Electricity," was read by Marshall Osborne, associate member.

STUDENTS' SECTION.—The report of the hon. sec. (Mr. H. D. Symons) of the work of this Section for the session 1901—2 shows that 13 meetings have been held during the session; the average attendance has been 33, and the discussions on the papers have been very enthusiastically entered into by the students; 13 works and installations of special interest in the neighbourhood of London have been visited by parties of students on various Saturdays during the session. The Council sanctioned a proposal by the Committee to visit Newcastle-on-Tyne during the Easter vacation of the technical colleges; 32 students took part in the visit, which lasted five days. The party arrived in Newcastle on Monday, April 7th, and attended the meeting of the Newcastle Local Section held at the Durham College of Science on that evening, being warmly welcomed by the chairman, Mr. J. F. C. Snell. A meeting was held at the Tyne Temperance Hotel on the Friday evening, April 11th, at which most of the students taking part in the visit were present. The party visited Stockton-on-Tees, Sunderland and Jarrow, besides other works in Newcastle.

South African Trade Commission.—It would seem that British manufacturers and traders are determined that, in the case of South Africa, British trade shall follow the flag. In this connection we notice in the *Times* the appointment of a representative committee of some of the leading manufacturers and traders of the United Kingdom. The committee includes such men as Col. R. E. Crompton (Crompton & Co., Limited, London), past-president of the Institution of Electrical Engineers; Mr. John Lockie, J.P. (shipowner, Newcastle-on-Tyne), chairman of the Central Council, National Industrial Association; Mr. John Thomson (merchant), president of the Manchester Chamber of Commerce; and Mr. George Conaty, M.I.Mech.E., president of the Birmingham Association of Mechanical Engineers. The operations of this committee will include the sending out of three experts to South Africa to inquire into, and report on the state of, and openings for, trade there. They will represent the leading industries, the most important of which is engineering, the commissioner for which has just been appointed in Mr. Ben. H. Morgan, the editor of the *Engineering Times*. The Colonial Office is assisting the work of the Commission and granting the deputation travelling facilities through the military lines. The deputation, who will leave England the first week in June, will return from South Africa in about three or four months' time, and their respective reports will be awaited with much interest by manufacturers and traders throughout the country.

Incorporated Gas Institute.—The thirty-ninth annual general meeting of the Incorporated Gas Institute is to be held at Southampton, under the presidency of Mr. S. Westall Durkin, the gas engineer there, commencing June 10th. A civic welcome is to be accorded the members at the opening of the proceedings. The programme includes a lecture on "Electric Traction and Electrolysis," to be delivered by Mr. James Swinburne, M.Inst.C.E.

Platinum.—The platinum output in New South Wales in 1900 was only 530 ozs., value £1,007; and the total quantity raised since the beginning of 1894, 8,295 ozs., valued at £12,432. Platinum mining in N.S.W. is limited to a great extent, owing to the scarcity of water in the districts in which the metal is found. The N.S.W. platinum is obtained chiefly from Platina, a township situated two miles from Fifield and about 322 miles west of Sydney, where it is found associated with gold. It is probable that as fresh discoveries are made, an extensive and valuable branch of the State mining industry will be created.

New Engineering Magazine.—A welcome innovation in technical journalism is the foundation of the *Engineering Magazine*, of the University of Birmingham. The first number of this publication, dated May 15th, is the pioneer of its kind, and indicates that the new University intends to take a prominent position in engineering; it is to be the organ of the Engineering Society, and will appear twice during each term. Naturally, the editors are proud of their position of priority; they may reasonably take credit to themselves also for the excellent quality of their first issue, which contains articles by the Principal, Dr. Oliver Lodge, Profs. Burstall, Turner and Redmayne, and the editors. Under the heading "Lines of Force," some amusing editorial notes are given; we would suggest, however, that the too frequent references to intoxicating liquor throughout the issue are in bad taste. There is too much of this already in professedly technical journalism. The editors will please note also that the word *data* is in the plural.

Welsh Mines.—Prof. Galloway, of the South Wales and Monmouthshire University College, ex-deputy inspector of mines for the busiest part of the Welsh coalfield, recently stated in reply to inquiries, that he believed it would be possible to adopt electricity in all mechanical operations in connection with which compressed air and steam are now employed, with the exception of certain stipulated instances. He thought that there was a great future for electricity in colliery undertakings, except at the faces of fiery mines and in the return airways. It would, undoubtedly, be cheaper, and the fact that the South Wales Power Company are proposing to erect large and economical engines must necessarily enable them to supply the power at a very much lower rate than it could be produced for by installations at the individual collieries. Replying to a query as to whether electricity could be utilised in connection with coal-cutting machinery, Mr. Galloway said that it could not; compressed air would have to be used for this purpose, except in mines where naked lights were allowed.

Electric Automobile Fire Engine.—The Hanover T.C. has adopted an electric automobile fire engine. It has a speed of 16 km. per hour, and contains a battery of accumulators of 42 cells, furnishing current for a journey of 25 kilometres without recharging. Two motors are arranged to act independently of each other on the back wheels. The cost of the automobile and equipment is £1,200.

Electricity and Agriculture.—The Agricultural Society of Lombardy has decided to award a prize of 1,500 lire to the author of the best essay on the "Influence of Electricity on Vegetation and the Products of Agriculture," containing an *exposé* of the studies made in Italy and abroad in this connection. Essays should be sent to the Societa Agraria di Lombardia, Place Fontana, Milan, not later than September 30th, 1903.

The Electricals.—A well attended smoking concert took place at the Bedford Head Hotel on Friday evening last to close the winter session. The President, Sir David L. Salomons, occupied the chair, and a varied and enjoyable programme of music was gone through. We understand that several interesting summer trips are contemplated by the Committee, information as to which could doubtless be obtained from the hon. secretary, Mr. F. E. Oldham, 3, Orchard Road, Highgate, N.

The Sarpsfos Carbide Factory.—The calcium carbide factory which derives its energy from the Sarpsfos Falls of the River Glommen, near the town of Sarpsborg, is the largest electro-chemical works in Europe. The falls themselves are 54 ft. in height; and the water passing over them in the summer months, April to November, is sufficient to develop 24,000 E.H.P., although in the winter this usually diminishes to 15,000 or 18,000, with an occasional minimum of 11,000. A special canal, 240 yds. long and 30 ft. wide, with a gradient of 5 per cent., has been cut out of the rock to lead the water to a reservoir, from which steel tubes 8 mm. thick in the walls conduct it to the turbines. These tubes are heavily lagged with wood and sawdust to prevent the penetration of frost. The water travels at the speed of some 9 ft. per second, each pipe delivering about 700 cub. ft. in that interval of time, and it drives six turbines of 1,400 H.P. each, four of 2,000, and two of 300, or a total of 17,000 H.P. The turbines are of the Jonval type, supplied by the firm of J. J. Rieter & Co., of Winterthur, and have a new undescribed electric regulator; the dynamos are built horizontally above the turbines, and have their vertical axes coupled directly to the latter. It is stated that over 5,000 tons of calcium carbide are being made annually by means of power supplied by these works, an estimate which should leave some 12,000 H.P. employed for other purposes. These include energy delivered to several manufacturers of briquettes, or compressed fuel, and a 5,000-volt supply to the town of Frederikstad, where it is largely consumed in saw mills. The factory is connected through an electric railway 7 kiloms. long with the main railway system, which a few miles below Sarpsfos passes the port of Sannesund, whence steamers leave every fortnight for Hamburg and Stettin. The erection of the power station has hindered the use of the Glommen for sending wood logs down to the sea, and so a special navigation canal has had to be constructed, as this industry is of considerable local importance.

Boilers for the Navy.—The six first-class cruisers now under construction are to have water-tube and cylindrical boilers in the ratio 4 : 1; two will have Niclausse, two Yarrow, one Dürr, and one Babcock & Wilcox boilers. It is noteworthy that the Belleville is excluded.

A Mare's Nest.—A correspondent, who does not favour us with his name, writes us as follows:—"Another Poser.—I should be greatly obliged if you would furnish me with the answer to the following question, set by the City and Guilds Institution at the recent examination. A dynamo takes 98 H P. to drive it, and runs at 500 revolutions per minute. If it is driven by a belt, and the pulley is 24 in. in diameter, what will be the difference in tension between the driving and the slack sides of the belt?—N. G. B., Burton-on-Trent."

Evidently "N. G. B." has in mind the induction motor with 15 poles, to which we recently alluded. Our readers will remember that some of our correspondents applied cut-and-dried formulæ to that problem with mechanical lack of discrimination; they had been taught to calculate, but not to think. Apparently, the examiner has here an easy prey; for "N. G. B," if he writes in good faith, is unaware that the question is a very elementary and easy one. The fact that students are so easily defeated is anything but encouraging, in view of the paramount need of thinking men to carry on our industries.

Shock Fatality.—An engineman employed at the Glapwell Colliery, Derbyshire, accidentally touched one of the electric wires which supply light to the works, and a current under a pressure of several thousand volts passed through his body. Death was almost instantaneous.

Personal.—Lord Rayleigh, Professor of Natural Philosophy at the Royal Institution, has been elected a corresponding member of the Imperial Academy of Science, of Vienna.

THE CENTRAL STATION ENGINEER.

Mr. Cecil F. Love, of the Halifax Corporation Electricity Works, has been appointed to fill the post of chief assistant engineer at the Wycombe Electricity Works. There were 84 applicants. Mr. Love gained his experience at the electricity works at Reading, Shoreditch, West Ham and Halifax.

The Huddersfield B.C. has resolved that Mr. J. W. Turner be appointed senior engineer-in-charge, and his salary be increased from £117 to £150; that J. E. Schofield and E. Lunn be appointed engineers-in-charge, and their salaries increased from £78 to £91.

Mr. W. F. Stamp, late assistant electrical engineer to Wimbledon Council, having been appointed to the post of chief assistant electrical engineer to the Devonport Corporation, was entertained by his friends at Frascati's Restaurant, on Thursday last week. Mr. J. W. A. Binner, chief assistant engineer to the Bermondsey Borough Council, in presenting Mr. Stamp with a dressing case on behalf of the company present, congratulated him on his appointment, and wished him every success. A silver cigarette case and an address were also presented to him from the working staff of the Wimbledon Electricity Works, as a mark of their great appreciation of his courteous treatment and fair dealing. Mr. A. E. Young made a further presentation of a silver match box, on behalf of a few personal friends.

Last week Mr. Edward Cross, borough electrical engineer of Rotherham, was presented with a handsome silver tea set and silver mounted oak tray by the staff and employés, on the occasion of his marriage. The Mayor made the presentation, and spoke in highly complimentary terms of Mr. Cross's success in the conduct of the electrical undertaking, after which Mr. Cross made a suitable reply.

Mr. O. A. Pilcher, chief assistant electrical engineer to the Blackburn Corporation, has been appointed electrical engineer and tramways manager to the Borough of Ilkeston.

NEW COMPANIES REGISTERED.

City and Surrey Electric Railway Company, Limited (73,761).—This company was registered on May 17th, with a capital of £150,000 in £10 shares, to carry on the business of an electric railway company, to undertake the construction, maintenance and working of electric and other railways and tramways and motors therefor and their accessories and appurtenances, and to manufacture and deal in all kinds of vehicles, whether propelled or drawn by animal or mechanical traction, and all machinery, appliances, apparatus and things capable of being used in connection therewith, producers and suppliers of electricity for the purposes of light, heat or power, &c. The first subscribers (each with one share) are:—A. G. Ashwell, 79, Queen Street, E.C., solicitor; W. B. Langmore, 15, Park Lane, W., solicitor; W. Rigby, 19, Pascoe Road, Lewisham, Kent, railway contractor; S. Strickland, for the Widnes Foundry Company, Widnes; S. G. Fraser, 1, Victoria Street, Westminster, civil engineer; B. Drake, 66, Victoria Street, Westminster, electrical engineer; R. B. Maltby, Carbrook Steel Works, Sheffield, steel manufacturer; and C. S. Oxenburgh, 138, Ramsden Road, Balham, Surrey, gentleman. No initial public issue. The number of directors is not to be less than two nor more than eight; the subscribers are to appoint the first; qualification, £200; remuneration, £200 each per annum (chairman, £300).

Private Telephone Company, Limited (73,732).—This company was registered on May 15th, with a capital of £10,000 in £1 shares, to adopt an agreement with A. Reiner, and to acquire and turn to account any inventions relating to putting up and working private telephones, &c. The first subscribers (each with one share) are:—A. Reiner, Dashwood House, E.C., merchant; A. E. Whipp, 61, Mark Lane, E.C., shipping agent; R. T. Beard, 49, Clova Road, Forest Gate, contractor; T. A. Beard, 201, Romford Road, Forest Gate, lighterman; W. H. Feltham, 87, Tooley Street, S.E., manufacturer; and H. Field, Keyser's Royal Hotel, Blackfriars, E.C., manufacturer. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are A. E. Whipp, S. Taylor, W. H. Feltham, E. Atkins, E. A. Gibsons, E. H. Lamb and A. Reiner; remuneration as fixed by the company. Registered office, Dashwood House, E.C.

South African Works Syndicate, Limited (73,720).—This company was registered on May 14th, with a capital of £5,000 in £1 shares, to carry on the business of manufacturers of rolling stock, railway and tramway appliances, engines, machinery and plant of every description, iron and steel manufacturers and founders, engineers and contractors for railways, tramways, and all kinds of works and undertakings, to establish and maintain rail and tramroads, producers and suppliers of electricity for the purposes of light, heat or power, telegraph and telephone systems, &c. The first subscribers (each with one share) are:—C. Bassett, 118, Godolphin Road, Shepherd's Bush, W., clerk; J. E. Leuirs, 180, Tresillian Road, Lewisham, S.E., clerk; I. A. J. Smith, 78, Glengarry Road, East Dulwich, S.E., clerk; W. Nicholls, 31, Melgund Road, Highbury, N.; W. Howard, Princes Road, Buckhurst Hill, Essex, clerk; G. J. Smith, 2, Grosvenor Terrace, Station Road, Sidcup, clerk; and W. Tansley, 101, Blackheath Hill, S.E., clerk. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification and remuneration to be fixed by the company. Registered office, 110, Cannon Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Crystal Palace District Electric Supply Company, Limited (18,532).—This company's annual return was filed on April 2nd, when 47,859 shares were taken up out of a nominal capital of £75,000 in 75,000 shares of £1 each. £1 per share has been called up on 2,859, resulting in the receipt of £2,859. 45,000 shares are considered as paid. Mortgages and charges, £50,000.

Direct Spanish Telegraph Company, Limited (6,732 C.).—This company's annual return was filed on April 16th, when 12,931 ordinary and 6,000 preference shares were taken up out of a nominal capital of £95,000 in 13,000 ordinary and 6 000 preference shares of £5 each. £5 has been called up, resulting in the receipt of £94,655. No mortgages or charges.

Electric Works Company, Limited (55,892).—This company's annual return was filed on May 14th, when 507 shares were taken up out of a nominal capital of £10,000 in 10,000 shares of £1 each, 3s. per share has been called up on 500, and nothing on seven shares, resulting in the receipt of £75. Mortgages and charges—nil.

CITY NOTES.

Northern Counties Electricity Supply Company.

The directors of this company have just issued their first annual report to the end of the year 1901. This states that the capital issued is 100,000 ordinary shares of £1 each, and was allotted in February, 1901, consisting of 4,000 shares issued as fully paid, and 96,000 shares on which 5s. per share was paid. "During the year works have been in course of construction at Blyth, Cowpen, and Spennymoor, and designs have been made for the Alnwick and Hebburn stations. The expenditure on these amounted to £22,130 11s. 5d. to December 31st, 1901. The Blyth and Cowpen works began the supply of current to consumers about the end of the year, and since then steady progress has been made. Spennymoor is very nearly ready to supply, Alnwick is expected to be ready about the end of July, and Hebburn before the end of the year. The six provisional orders referred to in the prospectus have been duly transferred to the company, viz. South Blyth, Cowpen, Spennymoor, Barnard Castle, Malton and Thirsk. The other eight orders pending at the date of the issue of the prospectus were duly obtained in the 1901 Session of Parliament, viz., Alnwick, Annfield Plain, Consett, Benfieldside, Shildon, Handsworth, Norton and Pickering. The company has entered into a contract for working the provisional order held by the Hebburn Urban District Council, and application has been made for provisional orders for additional places in the colliery districts of Northumberland and Durham, while a Northumberland Tramways Bill is being promoted by the company. Since the end of the year the company has secured a transfer of the Whitley and Monkseaton provisional order, and has entered into a contract for working the Felling provisional order held by the Felling Urban District Council, similar to the contract for working Hebburn, with which it will be combined. It will therefore be seen that the company is already practically in possession of an extensive business, and the directors hope as soon as operations shall have been fairly begun that good and profitable results will follow."

Prospectus.

The Charing Cross and Strand Electricity Supply Corporation, Limited, has issued a prospectus inviting subscriptions to a new issue of 40,000 "City Undertaking" 4½ per cent. cumulative preference shares of £5 each at par. The dividend on these shares will be payable exclusively out of the net profits of the corporation's City Undertaking, and of any present or future investments by the corporation in the share capital of the Charing Cross and City Electric Company, Limited. As against these profits the City Undertaking preference shares will have an absolute priority over all other shares in the company. The total nominal amount of the City Undertaking preference shares is limited to £400,000. In the event of

the net profits from the City Undertaking being insufficient to provide these dividends for the period ending December 31st, 1903, any such insufficiency will be made up out of the net profits of the other undertakings of the corporation, after providing for the dividend on the 4½ per cent. preference shares of the general undertaking.

The capital already expended on the undertaking amounts to £645,060, and £300,000 is required to complete the buildings, machinery and mains. The capacity of the system will then be 375,000 8-c.p. lamps, and the trunk mains and station buildings will suffice for the supply to 600,000 lamps. The number of lamps already connected in the City area amounts to 79,000, while 21,000 have been contracted for, and contracts for 120,000 more are in course of negotiation, making a total of 220,000 lamps.

The directors do not propose to go to allotment unless subscriptions are received for the whole issue.

The list opened on Wednesday last and closes to-night.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending May 23rd were £993; corresponding week last year, £691; increase, £302. Total to date, £13,803; corresponding period last year, £12,055; increase, £1,748. Miles of track open, 11¾.

Blackpool and Fleetwood Tramways.—The receipts for the week ending May 24th were £1,357; corresponding week last year, £432; increase, £925. Total receipts to date, £6,227; corresponding period last year, £5,131; increase, £1,096.

Bristol Tramways and Carriage Company.—The receipts for the week ending May 23rd were £5,779; corresponding period last year, £4,680; increase, £1,099.

British Electric Traction Company.—The following returns are issued of the undertakings of this company for the week ending May 16th:—

Company.	Amount	Comparison with corresponding week of last year.		No. of weeks.	Aggregate.		
					Amount.	Inc. or Dec.	
	£	+ £	− £		£	+ £	− £
Devonport*	406	—	—	19½	7,787	—	—
Dudley—Stourbridge	677	1	—	19½	12,778	2,096	—
Gateshead¶	691	256	—	19½	12,564	323	—
Greenock-Pt. Glasgow	528	313	—	19½	8,015	4,535	—
Hartlepool	226	—	—	19½	3,889	281	—
Kidderminster ..	103	—	13	19½	1,933	133	—
Merthyr‡	184	—	63	19½	3,704	—	536
Middleton*	272	—	—	7½	2,111	—	—
Oldham—Ashton ..	509	—	14	19½	9,235	—	—
Poole†	225	—	47	19½	4,076	—	9
Potteries	1,437	10	—	19½	26,968	1,055	—
Southport	220	—	9	19½	3,317	896	—
South Staffordshire†	738	—	54	19½	14,248	586	—
Swansea	433	29	—	19½	8,069	752	—
Taunton*	66	—	—	19½	1,079	—	—
Tynemouth§	202	—	28	19½	3,895	203	—
Wolverhampton Dist.	135	81	—	19½	2,620	1,682	—

* Not in operation last year. † Partly steam. ‡ Comparison from April 5th only. § Comparison from March 18th only. ¶ Comparison from May 8th only.

Central London Railway.—The receipts for the week ending May 24th were £6,899; corresponding week last year, £6,166; increase, £733. Total receipts to date, £140,668; corresponding period last year, £130,103; increase, £10,565. Miles open, 6.

City and South London Railway.—The receipts for the week ending May 25th were £2,884; corresponding week last year, £1,845; increase, £1,039. Total receipts to date (21 weeks), £62,470; corresponding period last year, £41,612; increase, £20,858. Miles open, 6½; last year, 4½.

Dover Corporation Tramways.—The receipts for the week ending May 17th were £189 8s. 6d.; corresponding week last year, £188 4s. 10½d.; increase, £1 8s. 7½d. Total to date, £3,560 13s. 1d.: corresponding period last year, £3,456 4s. 10½d.; increase, £104 8s. 2½d. Miles of track open, 3. Car miles run, 1902, 5,105; 1901, 5,071. Number of cars, 11. Week ending May 24th, £259 0s. 0¾d.; corresponding week last year, £204 15s. 4½d.; increase, £54 4s. 8d. Total to date, £3,819 13s. 1½d.; corresponding period last year, £3,661 0s. 3d.; increase, £158 12s. 10½d. Car miles run, 1902, 5,221; 1901, 5,094.

Dublin United Tramways Company.—The receipts for the week ending May 23rd were as follows:—D.U.T. Co., £4,016 13s. 6d.; D.S.D. Co. £1,499 4s. 6d.; total, £5,515 18s. 0d.; corresponding week last year—D.U.T. Co., £3,853 5s. 8d.; D.S.D. Co., £966 12s. 3d.; total, £4,819 17s. 11d.; increase, £696 0s. 1d.; aggregate to date, £87,193 0s. 7d.: last year, £82,715 5s. 8d.; increase, £4,477 14s. 11d. Mileage worked, 46. (Whitsuntide, 1902.)

East Ham Tramways.—The receipts for week ending May 24th were £532 8s. 11½d.; total to date, £17,513 19s. 10½d. Started running June 22nd, 1901. Car miles run, 11,393. Number of cars, average 18.

Glasgow Corporation Tramways.—For week ending May 24th, £11,940 9s. 1d., compared with £11,835 11s. 6d. for same period in previous year. Aggregate to date since June 1st, 1901, £601,049, compared with £475,834 for same period in previous year.

Liverpool Overhead Railway.—The receipts for the week ending May 25th were £1,797; corresponding week last year, £1,565; increase, £232. Total to date £29,887; corresponding period last year, £32,376; decrease, £2,489. Miles open, 6 miles 57 chains.

Sunderland Corporation Tramways.—Week ending May 25th, £1,488 2s. 1d.; total to date, £8,578 16s. 4½d. Miles open, 17·87. Number of cars, 38.

STOCKS AND SHARES.

Wednesday Evening.

With the "Assurance of Peace" in the hopeful air, a sudden revival of business has sprung up in nearly all the Stock Exchange departments. Consols and Kaffirs are, of course, principally affected, but the strength of the first has brought about a renewal of interest in home rails, so that even Waterloo and City stock has risen a point. The extraordinary vivacity of the Kaffir Circus, on the other hand, is diverting attention from the miscellaneous market, and although the electricity supply department is fairly busy, the trade is of too retail a character to exert any particular influence over prices. Hence it comes about that our list is almost destitute of change, the fluctuations being countable on the fingers only of one hand. Nor are there many variations to record in the telegraph list.

Metropolitan shares continue to occupy the premier position so far as speculation goes in the supply section. Business in "Mets." is more active than it is in any of the other shares, but, despite the nearness of the time for publication of the arbitrator's award, the quotation hangs steadily around 17, which is £1 above the price ruling at the beginning of May. Edmundson's Ordinary are in good demand, but the Preference shares keep dull at 6¼.

Charing Cross and Strand are unchanged upon the appearance of the City undertaking prospectus, the advent of which we announced last week. By the way, some of our technical contemporaries should really be more careful to get their facts right when writing about coming issues, because wild guesses which turn out to be incorrect might easily prejudice the success of any company in placing new shares. Up to the present, a small nominal premium has been established upon the new City undertaking Preference shares, which appear to be a good investment, well secured both as to interest and capital.

It did not take long for the new issue of Colombo Electric Tramways Debenture stock to be subscribed, and we understand that the whole amount offered (£100,000) was covered by applications on the first day of the prospectus' advertisement. A 5 per cent. Debenture stock at par cannot be regarded as gilt-edged, but the stock makes a fair speculative investment to which no great risk is attached. The British Insulated Wire 4½ per cent. Debenture stock, which has been offered this week at par, labours under the disadvantage of comparison with the existing stock of similar description, which is quoted in the market at 101 to 104. As it can be bought about 103, and carries five months' dividend in the price, it cannot be said that there is much inducement to subscribe for the new, but possibly the Telegraph Manufacturing shareholders will assist in getting the stock placed. The statement of a financial journal that the existing Debentures were quoted at a small discount was evidently a slip.

Of the slight advance in Waterloo and City stock, mention has already been made. Central London issues are virtually unaltered, but for the Ordinary stock buyers have to pay very nearly the top price named in the Official List. It is generally expected that the dividend for the first six months of the current year will be 4 per cent.; this, of course, being the "lean" half of the railway twelvemonth. The drastic doings of Lord Windsor's Tube Committee have had no effect upon Stock Exchange prices, although perhaps the rise to 106¼ of London United Tramways Debenture stock may be traceable to the passing of the preamble of the line from Hammersmith to Palmer's Green. This scheme is under the ægis of the London United Electric Railway, whose connection with the Tramway Company is almost that of a child to its parent. Metropolitan Consolidated is strong at 83, but there is not much spring in Districts at 33.

British Westinghouse Debenture stock is growing scarce, and the price has improved to 3 premium; the Preference at 5⅞ have recovered the dividend. A good deal of business is passing in British Electric Tractions, and there is a possibility that the quotation may go to 15 before long. Nearly all the American shares have now been disposed of, and the market is all the stronger for it; the Preference are ¼ up. National Telephone descriptions are irregular, the weakness of the Deferred stock being offset by a small rise in the Third Preference shares. Potteries Debenture at 108½ are two points better.

In the Telegraph department, Eastern Extensions are firmly upheld, but their strength fails to communicate itself to Eastern Telegraph Ordinary. The cable companies are being begged privately and publicly to adopt some of the many wireless systems before the Americans step in and buy up the patents. We can hardly imagine that the level-headed and practical Telegraph directorates would take any notice of these suggestions. Marconi shares are listless at about 3¼, and do not look as though they had much more rise left in them. West Indian issues are again unchanged, despite the Guatemala, Martinique, and St. Vincent visitations, but Cuba Telegraphs are harder on the assumption that the island will go ahead again now that its modified independence has just been officially recognised by the United States, whose citizens seem to have about as much aptitude for colonisation as our Teutonic brothers possess.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation May 21st.	Closing Quotations May 28th.	Business done during week ended May 28th, 1902. Highest.	Lowest.
82,300	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	...	...	...	3½— 4½	3½— 4½	...	...
119,700£	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	70 — 80	70 — 80	...	...
804,720	Anglo-American Telegraph	Stock	73/6	3½%	61s.	44 — 47	44 — 47	...	...
3,097,640	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	88 — 90	88 — 90	89½	88
3,097,640	Do. do. Deferred	Stock	£1 7s.	5s.%	2s.	7 — 7½	7 — 7½	7	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	...	3½— 4	3½— 4	...	...
3,333,300$	Commercial Cable	$100	8 %	...	...	150 —160	150 —160	...	...
1,741,029£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	93 — 96	93 — 96	96	94
16,000	Cuba Telegraph	10	7 %	...	...	4 — 5 xd	4½— 5½	4½	...
6,000	Do. 10 % Pref.	10	...	...	...	12½— 13½xd	12½— 13½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	2½— 3½	2½— 3½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	8½— 9½	8½— 9½	...	...
30,800£	Do. do. 4½ % Debs.	50	...	...	...	98 —102 %	99 —102	...	...
60,710£	Direct United States Cable	20	3½%	3½%	...	9½— 10½	9½— 10½	...	...
101,300£	Direct West India Cable, 4½ % Reg. Deb., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	117 —127	117 —127	121	117
1,930,807	Do. 3½ % Pref. Stock	100	...	...	...	85 — 88	86 — 89	88	87½
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	106 —110 xd	106 —110	109	107½
360,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	12½— 13½	12½— 13½	13⅝	12½
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	107 —112	106 —110	108½	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	5¼%	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	99 —102 %	99 —102	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	8 — 9	8 — 9	8 1/16	8⅝
180,042	Do. do. 6 % Pref.	10	...	...	...	12½— 13½	12½— 13½	13½	12½
150,000	Great Northern Telegraph, of Copenhagen	10	...	15 %	...	26 — 28	26 — 28	...	...
75,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —103	99 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	37 — 41 xd	37 — 41	38½	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	100 —104	100 —104	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	2½%	...	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	...	..	¾— 1	¾— 1	...	...
983,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	95 — 99	95 — 99	...	...
200,000	Do Pref. shares	2	...	3⅛	3⅜	3½— 3⅝	3½— 3⅝	...	...
1,966,667	Do Def. Stock	100	...	60	64 xd	55 — 59	53 — 57	54⅞	53½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 14	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅞— 5⅛	5 — 5¼	5 1/16	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 97	94 — 97	...	...
500,000£	Do. 4 % Deb. Stock Red.	100	...	4 %	4 %	103 —107	103 —107	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	6 %	6 %	1 1/16— 1 1/16xd	1 1/16— 1 1/16	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8	7 — 8	...	...
3,303	Submarine Cables Trust	Cert.	...	...	...	110 —120	110 —120	...	...
58,000	United River Plate Telephone	5	7 %	...	...	4½— 5	4½— 5	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4½— 5	4½— 5	...	...
179,947£	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	...	...
165,600	West African Telegraph, 5 % Debs....	100	...	...	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	⅛— ⅜	⅛— ⅜	...	...
150,000£	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	11½— 12½	11½— 12½	12⅛	11⅞
75,000£	Do do. 5 % Debs. 2nd series, 1905 ...	100	...	...	...	102 —105	102 —105	...	...
348,777£	Do. do. 4 % Deb. Stock Red.	100	...	...	...	99 —102	99 —102	101⅛	100⅛
88,321	West India and Panama Telegraph	10	8%	...	...	¼— ⅜	¼— ⅜	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5½ - 6	5½ - 5⅝	5⅝	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3½— 4½	3½— 4½	...	
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 —104	101 — 104	...	...

ELECTRICITY SUPPLY COMPANIES.

100,000	Blackheath and Greenwich Dist. Electric Light, Ord. ...	1	...	...	...	⅛— ¼	⅛— ¼	...	...
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	...	...	...	100 —104	100 —104	...	...
19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	8 %	9 — 9½	8⅞— 9¼	...	...
20,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8⅞— 9¼	8⅞— 9¼	...	...
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9 — 10	9 — 10	...	...
50,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	5 9/16	...
250,000	Do. do. do. 4% Deb. Stock Red.	100	...	...	...	105 —107	105 —107	...	...
84,000	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5 — 5½	5 — 5½	...	...
150,000£	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	110 —113	110 —113	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	4 %	0 %	5 %	8 — 9	8 — 9	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	...	...
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	123 —128	123 —128	...	...
200,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	...	...	...	103 —106	103 —106	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	4 %	4 %	4 %	8 — 9	7⅛— 8½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	12 — 13	12 — 13	...	...
400,000£	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	107 —110	108 —111	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	7 %	...	6¼— 6⅞	6¼— 6⅞	...	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	6 — 6⅛	5⅞— 6⅛	...	...
120,000£	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	107 —110	107 —110	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	11%	12%	10%	10 — 11	10 — 11	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	...	...	4 — 4½	4 — 4½	...	...
250,000£	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	95 —100	95 —100	...	...
98,769	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	6½%	16½— 17½	16½— 17½	17½	17
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	111 —115	111 —115	...	...
250,000£	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	98 —101	98 —101	...	...
8,652	Notting Hill Electric Lighting	10	7 %	7 %	6 %	14 — 15	14 — 15	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	8 1/16	...
150,000£	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	1½— 2½	1½— 2½	...	...
50,000£	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2¾— 3½	3 — 3½	...	...
109,518	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11 — 12	11⅝	11½

* Subject to Founders' Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotation May 21st.	Closing Quotation May 28th.	Business done week ended May 32th, 1902. Highest.	Lowest.
		†							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	86 — 90	86 — 90	...	...
62,074	British Electric Traction	10	8 %	9 %	...	13½ — 14½	13½ — 14½	14¼	13⅞
90,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12½ — 12⅝	12½ — 13	12⅝	12⅜
600,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	124 —127	124 —127	126	...
70,000	British Insulated Wire Ord.	5	20 %	15 %	10 %	8 — 9	8 — 9	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5½ — 5⅝	5½ — 5⅝	...	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	8 %	...	13s. to 15s.	13s. to 15s.	...	...
50,000	¶ " " " 6 % Cum. Pref.	£1	...	6 %	...	16/6 to 17/0	16/6 to 17/0	...	...
105,731	Brush Elecl. Enging., Ord., 1 to 105,731	2	5½ %	5 %	Nil	½ — 1	⅝ — 1½	...	...
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	3 %	1½ — 1⅝	1⅝ — 2¼	1⅝	...
125,060*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	101 —104	101 —104	...	...
125,000*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	97 —100	95 —100	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	17 — 18	17 — 18	17½	17⅛
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½ — 6	5½ — 6	6	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	111 —115	111 —115	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	4 %	103 —106	103 —106	105⅝	105
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	4 %	103 —106	103 —106	105½	105
440,100	Do. do. Def. do.	Stock	...	...	4 %	100 —103	100 —103	102½	101½
855,000	City and South London Railway	Stock	1½ %	1½ %	2 %	73 — 75	71 — 74	75	72
54,000	Crompton & Co., Nos. 1 to 54,000	3	7½ %	8 %	...	3 — 3½	3 — 3½	3 5/16	3¼
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	103 —108 %	103 —108 %	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	2½ %	...	⅛ — ⅜	⅛ — ⅜	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	2½ %	...	2 — 3	2 — 3	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	75 — 80	75 — 80	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	82 — 87	82 — 87	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1½ — 1⅝	1½ — 1⅝	1½	...
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390... ...	2	...	...	...	2½ — 3	2½ — 3	2 13/16	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	97 —101	97 —101	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9⅝ — 10¼	9⅝ — 10¼	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	98 —101	98 — 101	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	17 — 18	17 — 18	17 1/16	...
35,000	Do. do. do. 4½ % Pref.	5	4½ %	4½ %	...	5½ — 6	5½ — 6	...	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	111 —115	111 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21 7/16	...
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	99 —102	99 —102	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½ %	3½ %	1½ %	4 1/16 — 4 1/8	4 1/16 — 4 1/8	...	...
10,000	† Do. do. Pref., £10 paid	10	5	...	...	10½ — 11	10½ — 11	...	...
7,500	Parker (Thomas), Limited, Ord., Nos. 1 to 7,500 ...	10	...	...	...	15½ — 16½	15½ —16½	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	6 %	...	... — ...	19/0 to 20/0	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	17½ %	20 %	34 — 37	34 — 37	35½	...
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	... %	...	...	103 —106	103 —106	...	...
25,000	Telegraph Manufacturing, Ord. Nos. 1 to 25,000	5	12 %	12 %	...	10 — 11 xd	10 — 11	10¼	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½ — 6	5½ — 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	91 — 94	92 — 95	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, $\frac{3}{16}$—$\frac{5}{16}$.
National Electric Free Wiring, —1.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14½—15.
Do. do. Pref. (£10 pd.), 10⅜—10⅝.

* From Birmingham Share List. ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (February 6th, 1902).

MARKET QUOTATIONS, Wednesday, May 28th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	42/-	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£88 10	£88 10	..
a " " " ..	per ton	£80	£80	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£18	£18	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£19	£19	..
a Lead, Nitrate	per ton	£24	£24	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3d.	3d.	..
a " Caustic (76/80%) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£85	£85	..
a Shellac	per cwt.	115/-	115/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	£6 5	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a " Crystals	per ton	£3	£3	..
a Bichromate, casks ..	per lb.	2¼d.	2¼d.	..
METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b " Wire, in ton lots	per ton	£224	£224	..
b " Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£40 to £110	£40 to £110	..
c Brass (rolled metal 9" to 12") basis	per lb.	6⅜d.	6⅜d.	..
c Tube (brazed)	per lb.	8¼d.	8¼d.	..
c " " (solid drawn) ..	per lb.	7d.	7d.	..
c " Wire, basis	per lb.	7d.	7d.	..
c Copper Tubes (brazed) ..	per lb.	8⅜d.	8⅜d.	..
c " " (solid drawn) ..	per lb.	9d.	9d.	..
g Copper Bars (best selected) ..	per ton	£69	£69	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£69	£69	..
g " Rod	per ton	£69	£69	..
e " Electrolytic) Bars ..	per ton	£68	£63	..
e " " Sheets ..	per ton	£75	£75	..
e " " Rod ..	per ton	£68	£68	..
e " " H.C. Wire ..	per lb.	8d.	8d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f " Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/0½	3/1 to 3/1½	dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i " Pig (Cleveland warrants) ..	per ton	49/6	49/1	5d. inc.
i " Forgings, according to size	per ton	From £11	From £11	..
i " Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i " Wire, galvanised No. 8 ..	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 12 6	£11 15 to £11 17 6	2s. 6d. to 5s. dec.
g " " Sheet	per ton	£13	£13	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p " rolled bars & rods	per lb.	1/- to 1/8	1/- to 1/8	..
p " " strip & sheet	per lb.	From 1/2	From 1/2	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i " " in bars		£58	£58	..
g Tin, block	per ton	£135 to £136	£136 to £137	..
g " foil	per lb.	1/6	1/6	..
n " wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals —				
" White Ant" brand	per ton	£35 to £65	£36 to £60	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j " 8 lea. Flax	per lb.	5½d.	5½d.	..
j " 3 ply 16 lbs. Russian ..	per lb.	5 13/16d.	4 13/16d.	..
j " 10 lbs. Russian, single ..	per lb.	4½d.	4½d.	..
j " 180 lbs. Jute rove	per ton	£10 2 6	£10 2 6	..
k Zinc, Sh's. (Vieille Montagne brd.)	per ton	£22 10	£22 10	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Edward Till & Co. i Messrs. Bolling & Lowe. j Messrs. Walter H. Hindley & Co.

Quotations supplied by { k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co. Ltd. p The Phosphor Bronze Company, Ltd.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME NOTES ON POLYPHASE MACHINERY.

By A. C. Eborall.

(*Paper read at Manchester, March 25th*, 1902.)

(*Continued from page* 876.)

The question of the armature core of standard generators can next be considered. Apart from such considerations as the shape and number of the slots, the slot insulation, &c., one or two points connected with the general arrangement of the core may be noted. The insulation of the individual stampings from one another is always effected in modern machines by means of thin paper pasted on the iron sheets previous to stamping; tissue paper made from wood pulp is to be preferred for this purpose, as it can be subjected to great heat and pressure without charring. With modern

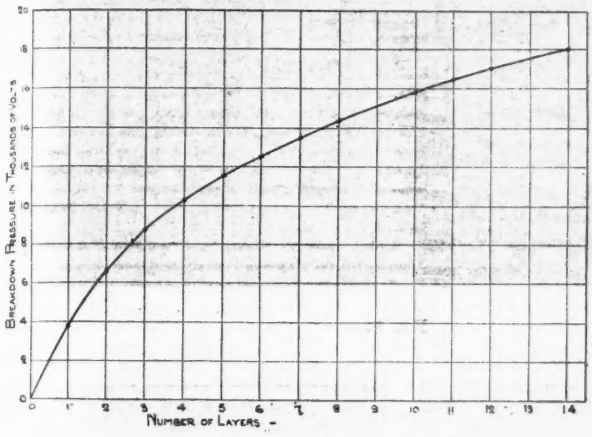


Fig. 12.

methods * of pasting the paper on the iron sheeting, the space loss, due to the paper, is not more than 10 per cent. It is also unnecessary, as a rule, to touch the slots with a tool after the core has been put together, as the slots line up quite truly without this, and are practically ready to receive the tubes or troughs of insulating material.

When assembling the stampings in the armature case, it is necessary to prevent the core from bulging, and to centre it properly; for this reason suitable provision should be made in the case for ensuring this. Referring to the design shown in fig. 2, for instance, it will be seen that dove-tailed shaped pieces are provided in the casing, which fit into corresponding grooves in the outer periphery of the core, and thus the correct position of the latter is assured. A similar arrangement is used in the large generator shown in fig. 3, the complete armature details of which are given in fig. 5.

The armature cores of large generators should always be bored out in the position they have to be ultimately erected in. If, for instance, a large armature is bored when in a horizontal position, no matter how stiffly it may be constructed, it will become considerably distorted when placed vertically in the pit, for it is then acted on by its own weight. It would generally be possible to correct the distortion and to adjust the air-gaps to equality all round, owing to the special arrangements provided with such large machines, which have already been referred to, but (just as in other classes of large engineering work) it is always preferable to machine the parts in the position they will have to be placed in afterwards.

With regard to the slots in the armature core, both the shape and number (per pole per phase) of these depend on the duty of the generator and the views of the individual designer. Without discussing these points in detail, it may be pointed out that the great disadvantage of pure hole windings is that the coils have to be hand wound, and, in the author's opinion, for this reason alone, such windings will be comparatively rarely used in the future. The modern tendency in this country is to use either bar windings or former-wound coils, depending upon the size of the generator and the nature of the work it has to do. The practical advantages of such windings, both from the manufacturer's and user's point of view, are so considerable that the disadvantages appear small in comparison. Both former-wound coils and bar windings (the bars of which have been previously bent to shape upon formers) necessitate the use of open slots. The use of the former places a practical limit on the number of slots per pole per phase that can profitably be employed, while the use of bar windings enables this number to be fixed from considerations of the electrical and magnetic design of the machine. Generally speaking, the more the winding is distributed the better; the limit to the number of slots is given by the design of the field system, and considerations of slot insulation with reference to the working pressure.

When former-wound armature coils are used, it is unusual to employ more than two slots per pole per phase for their reception. Naturally one larger slot per pole per phase would be mechanically preferable, and also cheaper, but the distribution of the winding in such large slots in this way is not advisable, for, apart from the variations in the flux and greater armature leakage and noise that would thereby result, an E.M.F. wave with a pronounced third harmonic would result. In large plants every effort should be made to get rid of these higher harmonics by careful designing, for they are objectionable in several ways; for instance, they cause increased losses and throw additional stresses on the insulation of the system, and may cause large rises of pressure over it. If there is one fact connected with alternating current working that experience has more firmly established than any other, it is that for all conditions of working and for all classes of work, a sinusoidal E.M.F. wave is the best.

With bar windings such a wave shape is readily obtained, as the armature winding can be well distributed in many (relatively small) slots per pole per phase; of course, in addition, the ratio of effective pole-shoe width to the pole pitch must have the correct value (about 2 : 3), while the pole-shoes themselves must be correctly shaped. Again, the alteration of the wave shape from no load to full load will be less with a well distributed bar winding than is the case with former-wound coils distributed in one or two slots per pole per phase.

The use of hand-wound armature coils does not represent the best modern practice, insomuch as such coils cost relatively too much to wind, and present the great disadvantage that, should a coil have to be replaced, it has to be cut out and the new one wound in (often under difficult circumstances) by hand; that is to say, a stock of spare coils cannot be carried for use in cases of breakdown, but an armature winder has to be sent for, which results in great delay and expense to the user of the plant. Moreover, with the larger generators having the armature in two or more parts, the coils crossing the division lines have to be wound in on site, and afterwards, should it ever be necessary to take down the machine in question, these coils have to be removed first, and afterwards again replaced by hand. The only way to get over this difficulty with hand-wound coils is to arrange the armature core in sections so that the section containing the defective coil can be completely removed and replaced by a new section containing new coils. Such a construction of armature core is clearly inadmissible for large generators, and is objectionable even when used for quite small machines, for there will be a considerable number of radial butted joints in the core; the latter, instead of being built up with over-lapping stampings (the joints in one layer being covered by the stampings of the next), will be formed of a number of complete segments held together by special arrangements in the armature casing. Thus the latter will become heavier and more expensive, while at the same time increased vibration and noise is bound to result, as well as an increased reluctance of the magnetic circuit and extra leakage paths for the armature ampere turns to act upon. Again, with three-phase generators, in order that the full benefit of this arrangement may be obtained, it is necessary to abandon the most favourable form of armature winding—this latter has to be carried out in three, instead of two, planes—as otherwise the coils crossing the radial division lines in the core would have to be removed before the corresponding segments could be taken out.

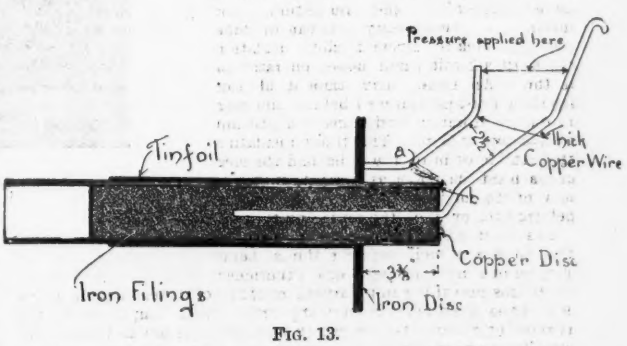


Fig. 13.

For these reasons former-wound coils or bar windings are far preferable. At the same time it is clear that the latter can only be employed with the best results in very large (high pressure) generators, or in low pressure generators. For other machines, therefore, it is generally necessary to employ former-wound coils, placed in two slots per hole per phase whenever possible. Naturally such coils will consist of bars when the current to be handled is large and when more than two conductors per slot are required. Thus, for instance, the windings of the 3,500-kw. generator illustrated in fig. 3, which consist of 10 bars per slot, are *former-wound*; a complete coil consists in this case of two rectangular micanite tubes containing five conductors in series, each conductor consisting of two bars in parallel, the bars being suitably bent at the ends.

While it is of course permissible to arrange the conductors forming a single coil in two or more parallel circuits as above, it is not good practice to make use of parallel windings for the arma-

* This is nowadays done by a special machine, which enables about 6,000 ft. of sheeting, 4½ ft. wide, to be covered in the most effective manner in a day of 10 hours by two men.

ture as a whole; thus, for instance, considering one phase, this must not consist of two sets of coils in parallel, for the sets of coils in parallel would not be equally loaded, and internal currents would circulate in them. Again, mesh connections are not advisable for the armatures of three-phase generators, as mesh-connected armatures (which would otherwise be suitable for large low-pressure generators) are very liable to increased losses due to the circulation in the windings of internal currents caused by the higher harmonics.

With regard to the insulation of the armature slots, micanite is usual for large high-pressure generators, used in the form of tubes or troughs. For pressure below 5,000 volts, however, compressed paper tubes can be used with good results; such tubes were first used by Messrs. Brown, Boveri & Co., and have been used by this firm with excellent results. The curve in fig. 12 gives a good idea of the character of the resistance offered by slot insulation to puncture of the material; curves of this kind are of the same general character for the different materials used for slot insulation, although of course the values for the breakdown pressure vary considerably, the highest values being obtained with micanite. The curve given in fig. 12 is for the best quality of (bright yellow) oiled cloth, about 0·0055 in. in thickness; the number of layers are plotted against the value of breaking down pressure. Such a material as this, which is, as will be observed, very reliable, when suitably built up mechanically to the proper thickness, can quite well be used as slot insulation for pressures up to 5,000 volts.

For 2,000-volt machines in which the armatures are wound with one or two bars per slot, the bars themselves can be covered with micanite and then slipped into the (lightly insulated) slots. Such micanite-covered bars are, the author believes, somewhat of a novelty, but for higher pressure than 2,000 volts, separate insulating tubes are preferable as a rule. The micanite is pressed upon the bars under considerable pressure, so that the conductor and its micanite covering form together a solid insulated bar very convenient to use.

The difficulty in insulating the armature conductors of high-pressure generators (or stator conductors of similar motors) does not lie in the slot insulation, but in preventing arcs from jumping the air space between the nearest uninsulated metal part and the ends of the coils. It is therefore of the greatest importance to keep the distance in question sufficiently great. There is no advantage, therefore, in employing a large amount of slot insulation; for instance, a (best quality) micanite tube 0·16 in. thick is sufficient slot insulation for a 10,000-volt three-phase generator or motor. An unnecessary amount of slot insulation means a larger machine, and as a rule more vibration and noise, on account of the wider slots. The tubes insulating the slots must project well beyond the core on each side, being carried right up to the ends of the coils, and the minimum distance between the ends of the coils and the core heads must be made as large as possible, this minimum permissible distance being determined by the designer's experience.

To illustrate this point, particulars of an actual test may be given. Fig. 13 is a sketch showing the arrangement employed for the purpose of making the test, which imitates as closely as possible the conditions prevailing in an actual machine of large size. Fig. 14 is a reproduction of a photograph taken of the testing arrangements as actually made in the shops; in this figure the arc can be plainly seen jumping across from the conductor to what is the equivalent of the core head. The tube in question was subjected to a test of 1 hour 25 minutes' duration at pressures of 20,000—30,000 volts, as shown in the table given below:—

Time in minutes during which the tube was subjected to the testing pressure.	Value of testing pressure at 50 cycles.
25 minutes	20,000 volts.
25 „	23,000 „
10 „	25,000 „
10 „	28,000 „
15 „	30,000 „

The weakest position was at $a\,b$, which was a distance of about 2 in. At a pressure of 30,000 volts a brush discharge took place at this point, which was visible in daylight. At a still higher pressure a regular arc was formed at this place, as shown in fig. 14.

Such high-pressure arcs are very interesting (but somewhat expensive) to study. Fig. 15 (A and B)* illustrates their nature when produced between two horn-shaped metal rods at a pressure of 10,000 volts. The apparatus shown is, in fact, the well-known and very effective horn arrester of Messrs. Siemens & Halske, Berlin, which is generally used on the Continent for protecting

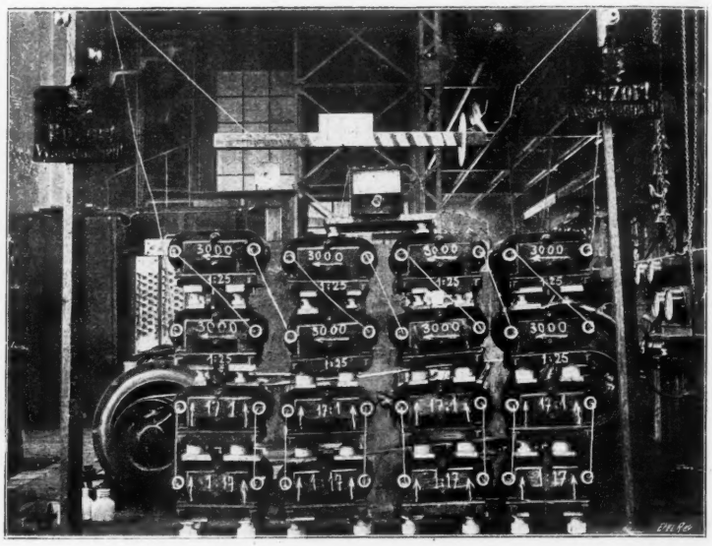


FIG. 14.

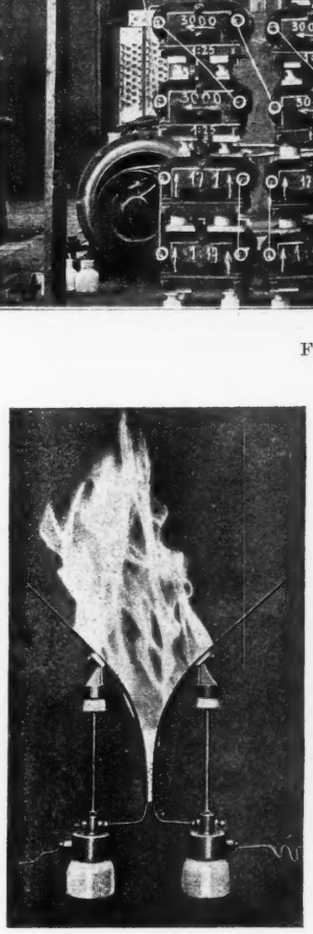


FIG. 15A.

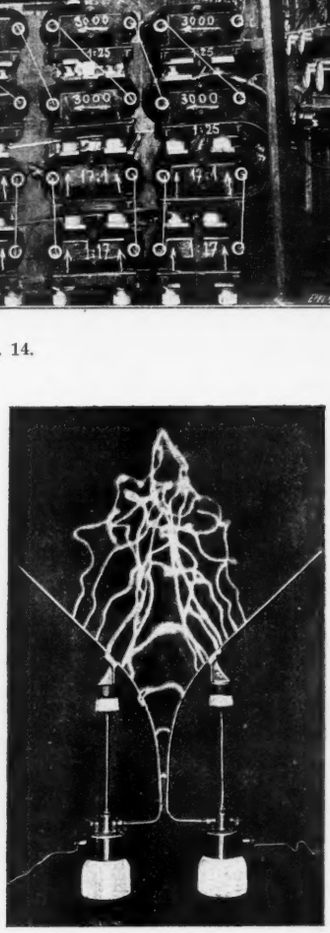


FIG. 15B.

overhead lines from the effects of lightning, and (sometimes) also for protecting high-pressure underground cable circuits from the effects of rises of pressure to which they are liable under certain conditions.

The photograph from which fig. 15A has been reproduced was taken with an exposure of about 2 seconds. Fig. 15B gives the results of a photograph taken through the slits of a rapidly-revolving disc, which enables the component parts of the arc to be separated out. Of course the special character of the horn arrester (which tends to put out the arc by reason of the action of the heated air, which drives it up the horns until the distance becomes too great to support it) causes the nature of the arcs shown in fig. 15 to be different from that of the arcs which may be formed in running machinery due to breakdown of the insulation; but this figure, nevertheless, gives a good general idea as to what such arcs are like, and for this reason the photographs in question have been reproduced here.

(To be continued.)

* The author is indebted to the courtesy of Messrs. Siemens and Halske for the photographs from which this figure has been reproduced.

ELECTRICAL TRACTION ON STEAM RAILWAYS IN ITALY.

By Prof. C. A. Carus-Wilson, M.A., Member.

(*Abstract of Paper read May 15th*, 1902.)

The Adriatica and the Mediterranean Railway Companies together work 80 per cent. of the railways in Italy. Each works about as many miles of line as the Great Western and Great Northern Companies put together.

For a long time past the Italian railways have been suffering from the competition of tramways and economic lines, which have provided a cheaper and more frequent service, seriously affecting the traffic on the main lines in spite of every effort made to minimise the injury thus caused. The adjoining map shows the network of steam tramways and economic lines that have spread over northern Italy. The railway companies have come to the conclusion that the remedy for this competition lies in providing, by means of electricity, a service of short trains running frequently at high speeds.

The Adriatica Railway Company has already equipped electrically that portion of its system running from Lecco to Colico, and thence to Sondrio and to Chiavenna (see map below). The electrically-driven trains are to work their own way as far south as Lecco, and to be hauled thence to Milan by steam locomotives. Trains are now running experimentally, but not yet in actual service.

The total distance at present electrified amounts to 66 miles, all of single track, a large proportion between Lecco and Colico being in tunnel. The hydraulic power house with turbines of 6,000 h.p. is at Morbegno, water being taken from the river Adda. Three-phase current is generated at 22,000 volts and carried by overhead conductors to nine transformer stations, where it is transformed down to 3,000 volts and taken to the two trolley wires, the rail forming the third conductor, and thence direct to polyphase motors on the cars.

The motor cars, of which a view is given in fig. 1, are 57 ft. long, weigh 53 tons unloaded, and have seating accommodation for 56 passengers. Each car is provided with two high-speed motors of 150 h.p., and two low-speed motors of 75 h.p. each, weighing 3·8 tons, and driving direct without gearing. Full speed is 37 miles an hour. The four motors are used in cascade connection at starting; at half-speed the two low-speed motors are switched out, and the car is driven by the two high-speed motors alone at full speed. On all grades over 1 per cent. the motors are connected in cascade and the speed thus halved. The trailers used are passenger carriages of the ordinary type. The goods traffic is to be hauled by electric locomotives.

The company are introducing a new "economic" system for working the line, by which they hope to reduce the traffic expenses, 80 per cent. of which is accounted for by the wages and salaries of the *personnel* at the stations.

The block system employed is the Webb and Thompson staff system, supplemented by an electric interlocking apparatus combined with an arrangement by which the trolley line at every station is divided into sections, each controlled by a switch, the opening and closing of which takes place simultaneously with the movement of the corresponding signal, so that it is impossible for a train to run on to a section against signals.

The Mediterranean Railway Company is equipping electrically the whole of the line from Milan to Gallarate and thence to Varese, Porto Ceresio, Laveno and Arona. The passenger receipts from these sections of line amount to about 2 per cent. of the receipts for the whole Mediterranean system.

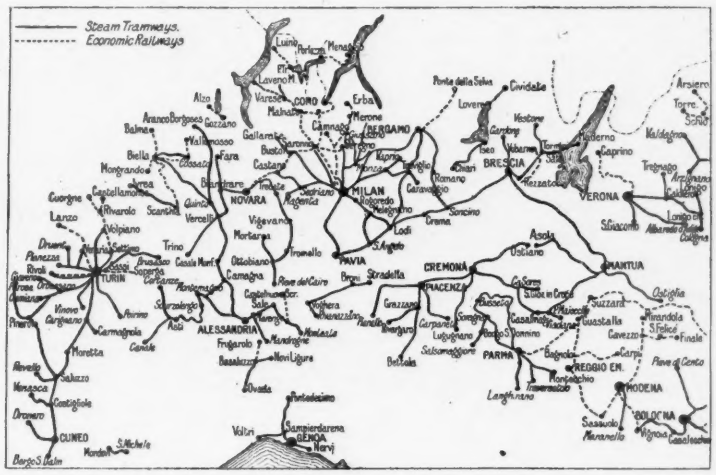
The total length of line is 81 miles, all of single track, except the length from Milan to Gallarate. The maximum grades and minimum curves are given in Table V. A map of the line is given in fig. 2.

The power house is at Tornavento, about seven miles from Gallarate. Turbines of a total of 11,000 h.p. will be driven by water taken from the River Ticino.

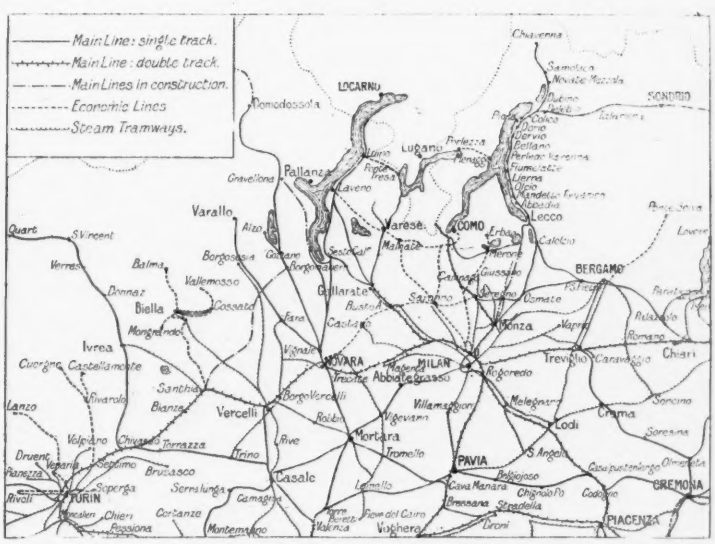
The power is transmitted as three-phase current at 12,000 volts to seven sub-stations along the line, where the pressure is reduced from 11,000 to 420 volts, and the current is transformed in rotary converters to direct current at 650 volts. From the sub-stations the current is taken to an insulated third rail, as shown in fig. 3.

The motor cars on the Varese line, shown in fig. 4, weigh 40 tons unloaded, and have accommodation for 63 passengers seated and 12 standing. Each motor car is driven by four 150-h.p. motors, on the usual one-hour rating, and is geared with a 3 to 1 ratio to 41-in. driving wheels. Full speed on a level is 56 miles an hour. Each motor weighs 2·5 tons. The trailers weigh 27 tons empty, and have accommodation for 63 passengers seated and 27 standing. The goods traffic is to be hauled by electric locomotives.

The electric trains are now running and in regular operation as far as Varese, though the service of trains as contemplated is not yet complete.



Map A.—Map showing Network of Steam Tramways and Economic Lines in Northern Italy.



Map B.—Map showing Railway Connections in the neighbourhood of Milan.

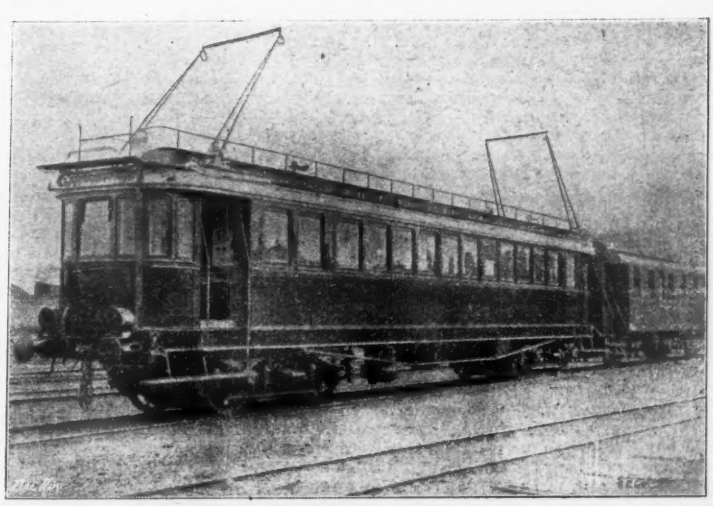


Fig. 1.

The working expenses of the Italian railways are given in Table II. These figures may be taken as representing the cost of running on either of the great systems. To afford a comparison, the figures for the cost of running an English railway are placed in the same table.

TABLE I.—COMPARING THE WEIGHT, POWER, AND DIMENSIONS OF THE POLYPHASE MOTOR CARS ON THE LECCO LINE WITH THE DIRECT CURRENT MOTOR CARS ON THE VARESE LINE.

—	Total weight empty.	Length of frames.	Seats.	No. of motors.	Maximum H.P. of each.	Total maximum H.P.	Weight of four motors.	Full speed on level.
	Tons.	Feet.					Tons.	M.P.H.
Varese	40	52	63	4	150	600	10	56
Lecco .	53	57	56	4	2 of 150 2 of 75	300	15·2	37

TABLE II.—RUNNING EXPENSES PER PASSENGER TRAIN-MILE.

	English.	Italian.
1. Coal	1·72d.	5·30d.
2. Wages of driver and stoker ...	3·81d.	3·18d.
3. Wages of conductor	1·52d.	2·08d.
4. Water, oil, &c.	0·77d.	0·60d.
5. Repairs, locomotives	2·39d.	3·52d.
6. Repairs, carriages	2·83d.	6·01d.
Total	13·04d.	20·69d.

TABLE III.—GIVING THE RECEIPTS AND EXPENSES PER MILE.

Fixed Expenses.	English.	Italian.
Maintenance of the line ...	£535	£132
Traffic expenses	1,350	236
General expenses...	537	53
Total	£2,422	£421
Running expenses	£1,750	£699
Receipts.		
Passenger traffic	£2,640	£640
Goods and miscellaneous ...	3,820	965
Total	£6,460	£1,605
Expenses in per cent. of receipts	65	70

In order to compare the running expenses with the fixed expenses they have both been reduced to pounds per mile per annum, and placed in Table III., together with the receipts estimated in the same way. The running expenses of an Italian railway constitute a far larger proportion of the total expenses than is the case on an English railway, the percentages being 62 in the former case and 42 in the latter. The receipts given for the Italian railways refer to the Adriatica system as a whole, and are greater than the receipts of the lines that are now being electrified.

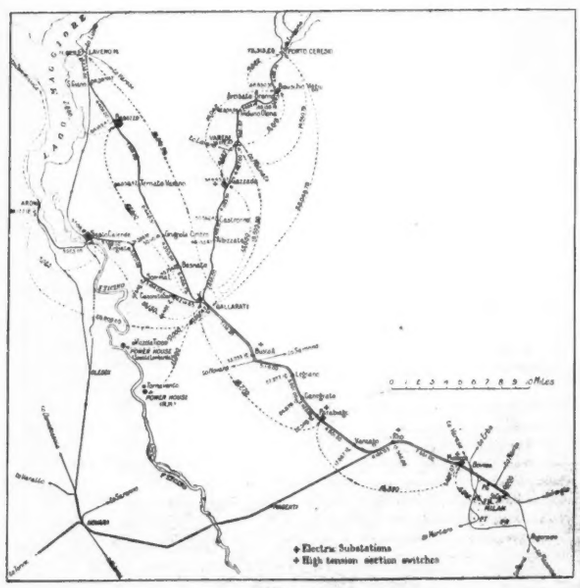


FIG. 2.

The fares charged on the various railway lines in Italy are given in Table IV. Column A gives the through express fares on the main lines, and column B the fares for the so-called omnibus trains which stop at all stations. Column C gives the reduced rates charged for omnibus trains on certain sections of the main lines, where the competition with the tramways and economic lines is most keenly felt. The rates on the economic lines are given in column E, while the tramway rates will be found in column F.

TABLE IV.—SHOWING THE PASSENGER FARES, IN PENCE PER MILE, CHARGED ON THE DIFFERENT ITALIAN LINES.

Lines	Main.				Economic.		Tram.
Power	Steam.		Electric.		Steam.		Steam.
Service ...	Exps.	Omnbs.	Exps.	Omnbs.	Exps.	Omnbs.	Omnbs.
Schedule speed (miles an hour)	25	16	45	25	25	16	9
Fares charged	Exps.	Ord.	Redcd.	Ordny.	Ordny.		Ordny.
	A.	B.	C.	D.	E.		F.
First-class ...	2·1	1·9	1·5	0·9	1·5		0·9
Second-class	1·4	1·3	1·0	—	1·0		0·7
Third-class ...	1·0	0·8	0·5	0·5	0·6		—

The service of steam trains that formerly ran on the Milan—Varese line is given in Table V., with the time occupied in covering the different sections. This may be compared with the new service of electric trains, particulars of which are also given in the table. The old trains, hauled by steam locomotives, have been replaced by trains of about half their weight, the normal train consisting of one motor car and one trailer, weighing together 67 tons unloaded, and capable of carrying 165 passengers, or about one-half the accommodation of the steam-driven trains. Between Gallarate and Arona and between Varese and Porto Ceresio the speeds have not been increased on account of the grades, which are as much as 2 per cent., and the trains will run with the motors in permanent series connection.

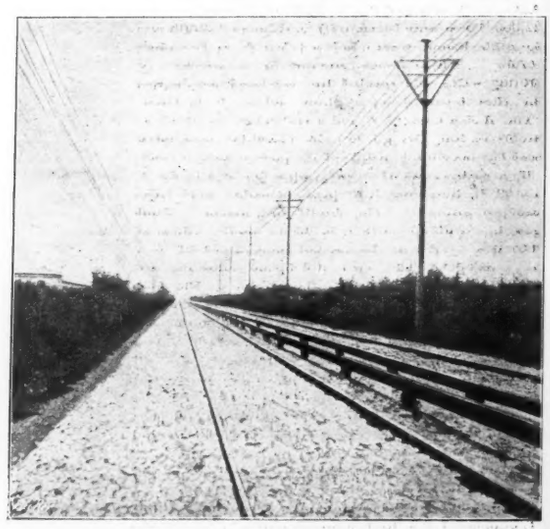


FIG. 3.

TABLE V.—GIVING THE STEAM AND ELECTRIC TRAIN SERVICE ON THE MILAN—VARESE RAILWAY.

—	Miles.	Max. grade.	Min. curve chains.	Trains each way per day.		Time in minutes.	
		Per cent.		Steam	Elect.	Steam	Elect.
Milan to Gallarate	25·0	0·6	40	10	35	60	34
Gallarate to Varese	11·7	1·0	25	7	27	28	18
Gallarate to Laveno	19·4	0·8	30	6	8	81	50
Gallarate to Arona	16·0	1·1	17·5	5	8	45	45
Varese to Porto Ceresio	8·8	2·0	15	5	6	28	28

The cost of running the new electric service on the Milan-Varese line may be estimated approximately from the cost of working the old service, and is given in Table VI.

ESTIMATE OF TRAFFIC.

The passenger traffic required to pay the expenses of the new electric service can now be estimated. On the Milan-Gallarate-Varese line the service is being increased from 8 to 28 trains per

day at a total increased cost of £775 per mile per annum. See Table VII.

The passenger receipts for this line, including the extensions to Arona and to Laveno, are £600 per mile per annum. Hence the passenger traffic must be increased by 129 per cent. to pay the interest and the increased cost of running.

TABLE VI.—SHOWING THE COMPARATIVE COST OF RUNNING AN ELECTRIC AND A STEAM LINE IN ITALY AND IN ENGLAND IN PENCE PER TRAIN-MILE.

—	Italian.		English.	
Trains each way per day...	Steam. 8	Electricity. 28	Steam. 8	Electricity. 28
Coal	5·30	3·40	1·72	1·07
Wages of driver and stoker	3·18	1·27	3·81	1·52
Wages of conductor ...	2·08	1·67	1·52	1·22
Wages at generating station	—	0·58	—	0·58
Wages at rotary sub-stations	—	0·58	—	0·58
Water, oil, &c.	0·60	0·45	0·77	0·58
Repairs, motors and generating station	3·52	1·76	2·39	1·20
Repairs, carriages... ...	6·01	3·00	2·83	1·41
Total ...	20·69	12·71	13·04	8·16
Figure used in the paper...	21·00	13·00	13·00	8·00

On the completion of the hydraulic power-station coal will no longer be used. The cost per train-mile will then be reduced to, say, 9·5d., and the increase in the passenger traffic required to meet this will be 80 per cent. With transformer sub-stations the increase need only be 72 per cent. The value of water-power may therefore be represented by a reduction of 20 per cent. in the passenger traffic required to pay expenses.

On the Lecco line the increase in the cost of running per mile of line, with transformer sub-stations, will be £150 per annum with water-power, which, with interest, brings the total increase to £325 per annum, and will require an increase in the passenger traffic receipts of 128 per cent.

On the line connecting Bologna with St. Felice the speed and the frequency of the trains were both doubled, and the fares reduced to 40 per cent. of their original amount. The result has been that the passenger traffic has increased five-fold, and the receipts have been doubled.

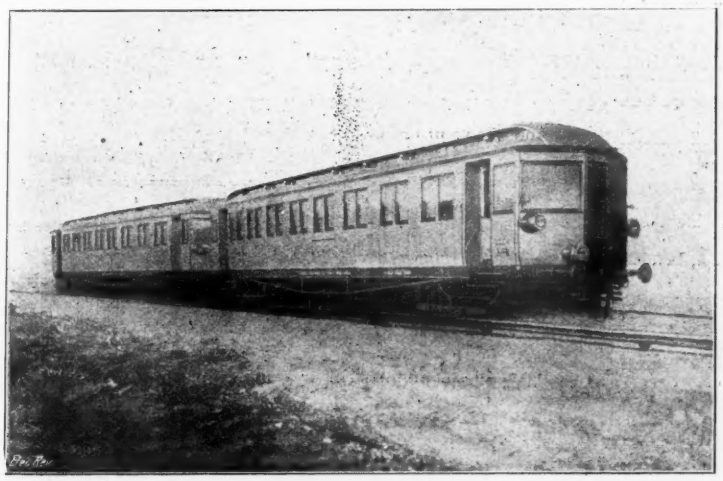


FIG. 4.

The new service on the Milan—Varese line has been inaugurated by the railway company in confident expectation that the improved service will increase the amount of traffic to such an extent that the receipts, even at the lower rates, will more than pay the expenses.

Under similar conditions in England, to make up for the increased cost of the electric service the passenger traffic would have to increase 61 per cent., if the fares were unaltered. With ½d. fares the traffic would have to be trebled.

It seems clear that, whether in England or in Italy, the full advantages of electrical traction cannot be obtained without an increase in the total running expenses, and this increase can only be met by a corresponding increase in the passenger traffic, so that the change from steam to electricity should not be made unless the increase in traffic may be reasonably expected at least to cover the increased cost of running and the interest on the capital expenditure.

It is not by reducing expenses that electricity is going to help the railways, but by enabling them to offer greatly increased travelling facilities to the public at a figure impossible with steam traction, and thus to meet the growing competition of the tramways.

TABLE VII.—SHOWING THE EXPENSES IN POUNDS PER MILE PER ANNUM OF RUNNING A STEAM SERVICE OF 8 TRAINS AND AN ELECTRIC SERVICE OF 28 TRAINS EACH WAY PER DAY IN ITALY AND IN ENGLAND.

—	Italy.			England.	
Power used	Steam. Coal.	Electricity. Coal.	Water.	Steam. Coal.	Electricity. Coal.
Number of trains each way per day	8	28	28	8	28
Cost in pence per train-mile*	21	13	9·5	13	8
	£	£	£	£	£
Running expenses... ...	510	1,110	810	320	680
Interest	—	175	175	—	280
Total	510	1,285	985	320	960
Increase	—	775	475	—	640
Per cent. increase in traffic required to pay expenses	—	129	80	—	61

* With rotary sub-stations.

The prospects of success in England with cheap coal are more favourable than they are in Italy with water-power, as is shown by the fact that the increase in the traffic required to pay expenses is less in England.

The possible increase in travel is far greater in England than in Italy, and if there is a field of usefulness for electrical traction on Italian steam railways, there is a still greater field of usefulness on the railways of our own country.

ALLOA ELECTRIC LIGHTING.

ALLOA has for years been the centre of several important industries, the chief of which are yarn and brewing. It is favourably situated for these, being on the River Forth, close to a good coalfield, and having railway connections from both the Caledonian and North British Railway Companies.

So far back as 1828, the town was lit with coal gas, and at the present time the town has the cheapest gas in Scotland, the gasworks being in the hands of the municipality. The question of electric lighting has, during the last few years, more than once been seriously brought before the Council, chiefly through the exertions of Bailie Arrol, who was ably assisted by Mr. Yuill, the gas manager, the original idea being that the electrical plant should be put down at the gasworks and driven by gas engines.

In May, 1898, at the request of the Council, Messrs. Buchan and Hogarth, of Edinburgh, prepared an electric lighting scheme on this basis, and the Council applied for a provisional order in November of the same year, the order receiving Royal assent in August, 1899. In the following autumn the Council was approached by the promoters of the British Electric Plant Company, who proposed to establish electrical manufacturing works in the outskirts of the town, and offered to supply energy in bulk to the Council. In view of the fact that it was anticipated that the establishment of the electrical works would be of the greatest benefit to the town, and that the taking of a supply in bulk would enable the Council to lay a much more extended system of mains at the commencement, the Council decided to conclude terms with the company, which was accordingly done early in 1900. The formal inauguration of the electric lighting took place on January 16th, 1902. Although the British Electric Plant Company are supplying current, it will be some considerable time before the equipment of their manufacturing works is completed. In the meantime they supply continuous current, which is distributed to consumers on the three-wire system at a declared pressure of 220 volts.

The current is brought from the company's works to the Corporation's distributing sub-station by trunk feeders, the positive and negative consisting of three cores each, and the neutral wire of a single 0·30 sq. in. conductor. The sectional area of each of the cores composing the positive and negative main feeders respectively is 0·25 sq. in. The supply is taken on the maximum demand system, and is metered at the Corporation sub-station, which is located in a central portion of the town. Balancing and earthing are done at the company's switch room. The distributing network consists almost entirely of 0·10, 0·06, and 0·10 sq. in. cable, with the exception of two of the principal streets, where the section is 0·125, 0·06, 0·125. The network is fed by two sub-feeders of section 0·15 and 0·25 sq. in. respectively, a feeder pillar being used to connect each of these to the network. The sub-station building consists of a

switch room, test room, and store. In the switch room is placed the main switchboard, which forms a connecting link between the trunk-feeders and the sub-feeders which convey current to the network. The board carries the usual complement of meters, switches, bus bars, plugs, &c., the pressure at the sub-station being shown on two illuminated-dial Kelvin voltmeters, and that on the network being indicated by the usual pilot voltmeters. The arrangement of bus bars and plugs is such that any sub-feeder can be isolated, and the design is arranged so that additional sub-feeders can be added without disturbing the existing connections, and also that accumulators can at any time be added should it be considered desirable to do so. In each sub-feeder circuit there is a Thomson-Houston watt-hour meter (fixed on the wall behind) and an automatic circuit breaker. From this switchboard connections are also taken to the arc-lighting switchboard, and for lighting the sub-station and testing.

The arc-lighting switchboard is also located in the Corporation switch room, and controls the 20 arc lamps which have been erected in the town. Both switchboards consist of enamelled slate set in iron frames, no combustible material being used in their construction. The arc-lighting switchboard consists of six panels, five being in use and one spare. The arc lamps are switched in groups of four, and are of the Crompton open type. The lamp pillars, which are of a graceful design, were made by the Alloa Iron Company, and erected by Messrs. Callender.

With the exception of the three-core trunk feeders and pilots, single cable has throughout been used, laid solid in bitumen contained in iron troughs with tile covers. Over 900 yards of Callender-Webber three-way casing has also been laid as spare cable way. The arc-lighting cable is ·06 sq. in. size, laid along with the distributor, but quite separate therefrom.

The meters used for consumers are Bastian for the small sizes, and Chamberlain & Hookham for the larger. Wright's indicators are also used. The prices charged are 7d. for the first hour's use of the maximum demand, and 3d. for every subsequent hour. For power, the rates are 7d. and 2d., with a special low flat rate for users who do not require their motors during the peak of the lighting load.

In addition to the street arc lamps, the connections applied for already are approximately the equivalent of 3,500 8-c.p. lamps, representing some 24 consumers, which is quite a good beginning. Several applications for motors have also been received. No meter rents are charged, and there is no free wiring.

The total cost of the works has not exceeded £10,000, including the building of the sub-station and incidental expenses, and it is claimed for the Alloa Council that it forms the first instance of a municipality buying its whole supply of electrical energy in bulk, and distributing itself. Certainly one great advantage of bulk supply in a town of this size is that the Corporation is enabled to lay mains in practically every street of any importance at the commencement of supply, thereby giving to the majority of the ratepayers the opportunity of at once taking advantage of the new light. In fact, when a bulk supply is taken on the maximum demand system, this course becomes almost a necessity, in order to get as good a diversity factor as possible. The Alloa Council has realised this, and, in consequence, applications are being rapidly received from all classes of consumers throughout the town.

The contractors for the work now executed were as follows:—

Cables and street work ...	Callender's Cable and Construction Company, Ltd., London.
Sub-station switchboards and equipment.	Messrs. Cox-Walkers, Darlington.
Arc lamps	Crompton & Co., Ltd. (erected by Messrs. Callender).
Pillars	Alloa Iron Company (erected by Messrs. Callender).
Meters, small size	Bastian Meter Company, London.
„ larger size	Venner & Co., London.
Demand indicators and house fuse-boxes.	Reason Manufacturing Company, Brighton.
Testing instruments	General Electric Co., London.

Material assistance was rendered both to the engineers and the contractors by the burgh surveyor, Mr. Mackie (under whose direction the sub-station was built), and the gas engineer, Mr. Yuill, who now has charge of the Corporation's distributing scheme.

The works have been carried out to the specifications of the Corporation's consulting engineers, Messrs. Buchan & Hogarth, Edinburgh, to whom we are indebted for particulars of the undertaking.

HOW ALTERNATING CURRENTS VARY WITH THE SHAPE OF THE E.M.F. WAVE.

By ALEXANDER RUSSELL, M.A.

When, experimenting with alternating currents, got either directly from the alternator or from the terminals of a transformer, curious effects due to change in the shape of the current wave are often noticed. The following mathematical investigation showing how the shape of the current wave depends on the resistance in the circuit, and how its effective value depends on the shape of the E.M.F. wave, may therefore prove useful to those engaged in experimental research with alternating currents.

Let the applied E.M.F. wave be given by the equation

$$e = E_1 \sin pt + E_3 \sin 3\,pt + \ldots .$$

where p stands for 2π times the frequency, and t is the time in seconds. We only consider the odd harmonics, as, in practice, the positive and negative halves of the wave of E.M.F. are exactly similar to one another. Consider now that this wave is applied at the terminals of a circuit whose resistance is R, and inductance L. The equation to determine the current i is

$$R\,i + L\frac{di}{dt} = E_1 \sin pt + E_3 \sin 3\,pt + \ldots$$

The well known solution of this equation is

$$i = \frac{E_1 \sin (pt - \phi_1)}{\sqrt{R^2 + p^2 L^2}} + \frac{E_3 \sin (3\,pt - \phi_3)}{\sqrt{R^2 + 9\,p^2 L^2}} + \ldots . (1)$$

Hence

$$i = \frac{1}{\sqrt{R^2 + p^2 L^2}} \left\{ E_1 \sin (pt - \phi_1) + \left(\frac{R^2 + p^2 L^2}{R^2 + 9\,p^2 L^2}\right)^{\frac{1}{2}} E_3 \sin (3\,pt - \phi_3) + \ldots . \right\} \quad (2)$$

The angle ϕ_{2n+1} is determined by the equation

$$\tan \phi_{2n+1} = \frac{(2n+1)\,p\,L}{R}.$$

When R is very large, ϕ_{2n+1} is nearly zero, and

$$\frac{R^2 + p^2 L^2}{R^2 + (2n+1)^2 p^2 L^2}$$

is nearly equal to unity, hence in this case the curve i is very similar to the curve e.

As R diminishes, the ratio of the amplitudes of the higher harmonics to the amplitude of the fundamental harmonic gets smaller and smaller and attains its minimum value when R equals zero. In this case

$$i = -\frac{1}{pL}\left\{E_1 \cos pt + \tfrac{1}{3} E_3 \cos 3\,pt + \ldots . \right\}$$

The diminution of the relative importance of the higher harmonics in the current wave as we diminish the resistance in an inductive circuit may be conveniently expressed by the following rule:—Diminishing the resistance of an inductive circuit makes the current wave more like a sine curve.

Again, if we have a condenser of capacity K in series with a resistance R, the equation to find i is

$$R\,i + \frac{\int i\,dt}{K} = e,$$

and the solution is

$$i = \frac{E_1 \sin (pt + \phi_1)}{\sqrt{R^2 + \frac{1}{K^2 p^2}}} + \frac{E_3 \sin (3\,pt + \phi_3)}{\sqrt{R^2 + \frac{1}{9\,K^2 p^2}}} + \ldots .$$

Hence, proceeding as before, we deduce the following working rule:—Diminishing the resistance in a condenser circuit makes the current wave less like a sine curve.

We will next consider how the effective value of the current in an inductive circuit depends on the shape of the wave of the applied E.M.F. The equation to the current in the circuit is

$$e = R\,i + L\frac{di}{dt}$$

Hence

$$e^2 = R^2 i^2 + 2\,R\,L\,i\frac{di}{dt} + \left(L\frac{di}{dt}\right)^2$$

$$= R^2 i^2 + R\,L\frac{di^2}{dt} + \left(L\frac{di}{dt}\right)^2$$

Integrating this equation over a whole period, and expressing the effective values of e and i by V and C respectively we get—

$$V^2 = R^2 C^2 + \frac{1}{T}\int_o^T \left(L\frac{di}{dt}\right)^2 dt \ldots \quad (3)$$

Now, from (1)

$$C^2 = \frac{V_1^2}{R^2 + p^2 L^2} + \frac{V_3^2}{R^2 + 9\,p^2 L^2} + \ldots .$$

Where $V_1^2 = \frac{1}{2} E_1^2$, $V_3^2 = \frac{1}{2} E_3^2$, &c.

And
$$L \frac{di}{dt} = L p \left\{ \frac{E_1 \cos (pt - \phi_1)}{\sqrt{R^2 + p^2 L^2}} + \frac{3 E_3 \cos (3 pt - \phi_3)}{\sqrt{R^2 + 9 p^2 L^2}} + \ldots \right\}$$

Hence
$$\frac{1}{T} \int_0^T \left(L \frac{di}{dt} \right)^2 dt = L^2 p^2 \left\{ \frac{V_1^2}{R^2 + p^2 L^2} + \frac{9 V_3^2}{R^2 + 9 p^2 L^2} + \ldots \right\} = a^2 L^2 p^2 C^2$$

where
$$a^2 = \frac{\frac{V_1^2}{R^2 + p^2 L^2} + \frac{9 V_3^2}{R^2 + 9 p^2 L^2} + \ldots}{\frac{V_1^2}{R^2 + p^2 L^2} + \frac{V_3^2}{R^2 + 9 p^2 L^2} + \ldots}$$

Now the numerator of this fraction is greater than the denominator, except when $V_3 = V_5 = \ldots = 0$ and the fraction then equals unity. Hence a has its minimum value unity when the applied E.M.F. is sine shaped.

Substituting in (3) we get
$$C^2 = \frac{V^2}{R^2 + a^2 L^2 p^2}.$$

Therefore for a given effective voltage, V, the current in an inductive coil is a maximum, when the wave of E.M.F. is sine shaped. This was proved experimentally by Messrs. Beeton, Taylor and Mark Barr.*

If ϕ be the phase difference between V and C, then
$$V C \cos \phi = C^2 R$$
$$\therefore \cos \phi = C \frac{R}{V}.$$

Hence ϕ is a minimum, and the power factor ($\cos \phi$) is a maximum for the sine wave.

Proceeding in the same way with a condenser circuit, we can show that the mean value of $\left(\frac{\int i \, dt}{K} \right)^2$
$$= \frac{C^2}{\beta^2 K^2 p^2},$$
where
$$\beta^2 = \frac{\frac{V_1^2}{R^2 + \frac{1}{K^2 p^2}} + \frac{V_3^2}{R^2 + \frac{1}{9 K^2 p^2}} + \ldots}{\frac{V_1^2}{R^2 + \frac{1}{K^2 p^2}} + \frac{1}{9} \frac{V_3^2}{R^2 + \frac{1}{9 K^2 p^2}} + \ldots}$$

The minimum value of β is obviously unity, and it has this value when the E.M.F. wave is sine-shaped.

Also
$$C^2 = \frac{V^2}{R^2 + \frac{1}{\beta^2 K^2 p^2}}.$$

In a circuit containing capacity and resistance, the current is therefore a minimum when the E.M.F. is sine-shaped. In this case also ϕ is a maximum, since $\cos \phi$ equals $C \frac{R}{V}$.

When we have both inductance (L) and capacity (K) in the circuit the problem becomes much more complicated. The current i is now given by an equation of the form,
$$i = \frac{1}{\sqrt{R^2 + p^2 \left(L - \frac{1}{K p^2} \right)^2}} \left\{ E_1 \sin (pt + \phi_1) + \left[\frac{R^2 + p^2 \left(L - \frac{1}{K p^2} \right)^2}{R^2 + 9 p^2 \left(L - \frac{1}{9 K p^2} \right)^2} \right]^{\frac{1}{2}} E_3 \sin (3 p t + \phi_3) + \ldots \right\}$$

The square of the coefficient of the $n + 1$ th term inside the bracket is
$$\frac{R^2 + p^2 L^2 \left(1 - \frac{1}{L K p^2} \right)^2}{R^2 + (2n + 1)^2 p^2 L^2 \left(1 - \frac{1}{(2n + 1)^2 L K p^2} \right)^2}.$$

If $L K p^2$ is equal to or is greater than unity, then this ratio will be less than unity when R is zero and will increase to unity as R increases to infinity. The circuit in this case therefore acts like an inductive circuit; diminishing the resistance makes the current wave more like a sine curve.

If $L K p^2$ is less than $\frac{1}{2n + 1}$, but is greater than $\frac{1}{2n + 3}$, then the ratio of the amplitudes of the 2nd, 3rd .... $(n + 1)$th harmonics to the amplitude of the first increases as we diminish R, but the ratio of all the subsequent harmonics to the first diminishes as we diminish R. Hence it is not easy to predict what effect increasing or diminishing the resistance will have on the shape of the current wave.

In practice, owing to magnetic leakage in the armature of the alternator, or in the secondary windings of the transformer, we always have some inductance in series with the condenser, and this has to be taken into account in determining how the shape of the current wave alters with the resistance in the circuit. An experimental investigation of how the shape of the current wave in a condenser circuit alters with the frequency has been made by Mr. T. Mather.* The curves were drawn by means of a Duddell oscillograph, and illustrate in a very striking manner the great importance of the higher harmonics of E.M.F. waves in alternating current supply systems, and point out possible dangers in connection with resonance.

The following experiment illustrates the kind of effect sometimes noticed by electricians, which is due to change of shape of the current wave. The primary circuit of a small transformer converting from 100 to 200 volts was connected to the 100-volt mains of a supply company. Across the secondary terminals was placed a condenser whose capacity was two microfarads, in series with an adjustable resistance. Now on increasing this resistance we expected that the primary current would first increase and then diminish. We found that when the adjustable resistance was zero the current in the primary was 0·67 ampere. As the resistance increased the primary current diminished, attaining a minimum value of 0·62 ampere when R was 35 ohms. It then increased to a maximum value of 0·915 ampere when R was 1,500 ohms, and finally diminished to 0·74 ampere, its value on open circuit when R was infinite. The secondary current of course continually diminished as R increased. The alteration of the shape of the current wave was proved by the ratio of the volts at the condenser terminals to the secondary current continually increasing as the resistance in the circuit was increased.

REVIEWS.

Steam Boiler Practice. By W. B. Snow. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

This book is somewhat of a companion to Poole's "Calorific Power of Fuels," by the same publishers. The author is well known for his writings on subjects connected with steam boilers. He deals in this book with steam boiler practice, discussing water, fuel, the chemistry of combustion, efficiency, rates of combustion, and draught. To begin with, the limit of evaporation per pound of coal is set down at 11 lbs. from and at 212° F., and this is probably all that can be counted on, even with the best of conditions. The commercial efficiency of boilers is briefly discussed in terms of durability, interest charges, and sinking fund, the most economical boiler being that which gives the best net result. In this respect, however, it should be remembered that freedom from stoppage by breakdown is of vital commercial importance, and that on land especially, simple devices of less fuel economy may be preferable to elaborate devices for securing economy.

We need not discuss the chapter on steam and water, as this is merely the ordinary discourse on the subjects, with Porter's table of the properties of steam reprinted.

* *Journal of the Institution of Electrical Engineers*, Vol. xxv., p. 474.

* "Capacity Currents as Influenced by Frequency." T. Mather, the Electrical Review, May 31st, 1901.

In the chapter on combustion, air is credited with 20·96 per cent. of oxygen by volume and 79·04 per cent. of nitrogen, or respectively 23·17 per cent. by weight and 76·83 per cent., the other gases being neglected. The chemistry of combustion is treated in a simple elementary manner, and there are some useful tables relative to proportions of CO_2. We cannot quite understand what is meant by the reference to an almost perfect *evaporative efficiency* secured with 11·2 per cent. of air below chemical requirements. The italics are ours. We should be inclined to doubt even the able expert who reported it. At the same time, we fully admit the possibility of less air being required with a good mechanical draught, and think that 15 lbs. of air per pound of coal may be achieved with advantage. Below 15 lbs. is difficult to secure, and we should never aim at the so-called chemical minimum, seeing that there is great probability of mass action coming into the account. The evils of excessive air are recognised. There is a slight error in the statement that in calculating the ideal temperature of combustion of fuel, it makes no difference if the oxygen is got from the coal itself or the atmosphere. Now it does make a difference, because the oxygen of the air is gaseous, and the oxygen of the coal is locked up solid, and demands so much heat to be locked up to set it free.

The chapter on fuels is very much like all other chapters on fuels. The fuel tables are practically the same as those in other American books, and are largely made up of particulars of American coals.

Natural gas fuels are practically out of consideration in this country. We only know of the existence of one natural gas well in England, namely, that at Heathfield, in Sussex, which supplies the gas to illuminate the railway station there. The borehole that yields it was made with a view to water.

A good practical paragraph is that on the influence of size of coal. In anthracite practice the American plan is to sort it into grades from pieces as big as 7 in. down to $\frac{3}{32}$ in. sieved sizes. Something like a dozen grades are sold. With all particles of equal size more even burning is secured. These American anthracites only burn well with a sharp draught, and the fuel must not be disturbed on the grate. With the finer grades it is often the practice to combine a little bituminous fuel.

The efficiency of fuels is well covered with numerous diagrams, tables, &c.; the effect of air excess is emphasised, and the commercial cost of evaporation. Apart from the mechanical appliances necessary, the cheapest coal in cost of evaporation per 1,000 gallons is the coal that costs least per ton. This confirms English practice, which all points to the calorific capacity of coals being superior to their value as fine coals. The fact is, that the price of coal is proved by its ability to burn quickly. Hence a rule laid down in these columns, that, generally speaking, the cheapest coal to use, or that can be used in any special case, is that which will burn in sufficient quantity to raise sufficient steam with the available fire-grate.

As a rule fire-grate area is too scanty to admit of much freedom with small coals, and where small coals are available, it is always necessary to calculate the capital cost necessary to provide the grate area to burn them.

In close connection with these questions comes that of draught, for, by means of a fan draught, an insufficient plant may be rendered sufficient for its duty with cheaper coals. It is in this way that a fan draught may often return very large percentages on its outlay.

The author objects to the application of evaporation from and at 212° as a basis for defining the efficiency of a boiler. There is a distinction to be drawn between the efficiency of a boiler and of the fuel. We need not closely follow the question of rating of a boiler. This is so largely a question for each case, that special rules are very unreliable. The usual standard in America is the evaporation of 34½ lbs. of water from and at 212° F. This is equal to 33,317 British thermal units per hour, which has the advantage of being easily remembered from the foot-pound value of the horse-power. But after all it takes an engineer to buy a boiler. Mechanical stoking is very briefly referred to, after which comes a chapter on rate of combustion, and the effect on this of draught, forced and otherwise. Draught is very fully treated, and the efficiency of chimneys calculated and compared with fan draught. The subject of steam boilers is well treated throughout, and we can cordially recommend the book as a good and safe guide.

The Law Relating to Factories and Workshops, with Appendix of Special Rules, Truck Acts, &c. By Evans Austin, M.A., LL.D., of the Middle Temple, Barrister-at-Law. London: Knight & Co. Crown 8vo., for cash 6s. 6d.

The passing of a new Act of Parliament which makes important changes in the law is nearly always followed by the appearance of new legal text-books. That which we now have before us is the second edition of an important work upon the Factory Acts, rendered necessary by the amendment and changes introduced in the law by the Act of 1902. If there is one branch of the law which demands the attention of electrical engineers more than another, it is the law of factories and workshops. It may be useful, therefore, to give a somewhat full account of what the volume contains, particularly as electrical stations were expressly brought within the provisions of the Act of 1902.

An interesting and useful feature of the introduction is a summary of the changes made in the law by the Act of 1901. Owing to the fact that all the older Acts were repealed and re-enacted in one long statute, the layman is unable, except with the aid of a book like that before us, to say what parts are new and what are old. Among the more important changes Mr. Austin mentions the following:—(1) The Secretary of State is to have power to enforce the provisions of the Public Health Acts in factories if he finds that the local authorities are in any way lax in the matter; (2) The temperature and ventilation of factories are in future to be under the control of the factory inspector; (3) Any steam boiler used in a factory is to be the subject of periodical inspection, and is to be regarded as a dangerous machine; (4) With regard to the provision of means of escape in case of fire, certain factories must be provided with means from the basement to the top floor, and must have a certificate to this effect from the District Council; (5) An important series of new regulations for dangerous trades is to come into effect on some date to be fixed by the Secretary of State; (6) Certain railways are for some purposes to be regarded as factories; and (7) Electrical stations, *i.e.*, any premises or that part of any premises in which electrical energy is generated or transformed for the purpose of supply by way of trade, or the lighting up of any street, public place or public building, or of any hotel, or of any railway or other industrial undertaking have been added to the list of non-textile factories which are subject to the provisions of the Act.

The body of the work consists of the text of Factory Act, 1901, printed in large type, with full and careful notes added where necessary to explain the provisions of each section. In order to indicate the source from which each section has been derived, the side-notes give references to the repealed Factory Acts, 1878—1895. When a section or any part thereof is new, the date "1901" is printed in the margin.

Certain sections, which in complexity and difficulty of interpretation bid fair to rival the famous Workmen's Compensation Act, have been noted in such a way as to greatly diminish the labour of those who desire to thoroughly understand them. For instance, Sec. 14, which makes provision for means of escape in case of fire, contains eight complicated sub-sections. The meaning of all these is carefully explained in five pages of notes, containing references to all important cases decided in recent years—including some decided in November, 1901.

Perhaps the most important part of the work is that which deals with Part V. of the Factory Act, 1901, relating to "special modifications and extensions." In this part of the Act, the Legislature has made an attempt to limit the application of the factory laws as applied to certain industries, &c., with the result that the definition of the term "factory" has to be modified. For the purpose of arriving at a correct definition of this term, Mr. Austin has made free use of those workmen's compensation cases in which a "factory" has from time to time been defined.

Throughout the work the orders of the Secretary of State

relating to particular industries may be found in their proper places. The fact that about 120 decided cases are referred to in the notes, affords some indication of the amount of labour which the author has expended upon his work.

The appendix deals in the first place with the Truck Acts, 1831—1896, to the sections of which full explanatory notes are appended. In the preparation of some of these notes the author has had the assistance of Mr. W. Valentine Ball, of the North-Eastern Circuit. As our readers are probably aware, the Truck Acts prohibit the payment of a workman's wages otherwise than in current coin of the realm. It seems that the chief difficulty connected with the Truck Acts has been the definition of the word "workman," but the cases set out at pp. 288 and 289 seem to provide a full legal definition of the term.

We also find in the appendix the Shop Hours Acts, 1892—1895; the Seats for Shop Assistants Act, 1899 (annotated); certain important provisions of (1) the Public Health Acts, 1875—1890, (2) the Public Health (London) Act, 1891, and (3) of the Elementary Education Acts; the Revised Regulations published by the Board of Trade in 1900; the Prevention of Cruelty to Children Act, 1894; the Quarries Act, 1894; 42 pages containing all the special rules published from time to time for the regulation of various trades and industries, and, lastly, the text of the Workmen's Compensation Acts, 1897—1900.

An elaborate index completes the second edition of a work which ought to prove very useful to the factory inspector and the lawyer, as well as to the occupiers of factories, who will find their statutory duties and responsibilities set forth and carefully explained in Mr. Austin's volume.

Pumps: Their Construction and Management. By PHILIP J. BJORLING. London: P. S. King & Son. 1902.

This book, reprinted from the *Engineering Times*, has for its object the description of various pumps ordinarily in use, with hints on practical points to be considered in their construction. Such a book is needed. We can quite sympathise with the author when he refers to the different treatment meted out to a pump from that given to a steam engine, even under the same charge. A pump, it is true, must often work under adverse conditions, but there is no occasion, of course, deliberately to design adverse conditions; yet too frequently such conditions are deliberately designed, and we find pumps put into unnecessarily dark and dirty places. One hears much of the slip of a pump, or its departure from a 100 per cent. volumetric efficiency. There is no excuse for many of the poor efficiencies shown by pumps; these are too often attributed to slow movements of valves which do not close sufficiently quickly to prevent reflux of the water. Frequently, however, the efficiency falls below 100 per cent., because there are places in which air can lodge. Pump designers apparently forget that air expands when relieved of pressure, and that a small volume of imprisoned air on the suction side of a lift pump will account for a serious diminution of the output, and may even stop the action of the pump altogether.

On the other hand, under certain conditions, a pump can be made to deliver more water than will fill the volume generated by the bucket. To enable this to be done the bucket must travel fast, and the suction pipe must be as small as consistent with ability to pass the amount of water. In this way the principles of the hydraulic ram may be brought into action.

An illustration is given of a set of three centrifugal pumps in series, and on the same spindle, for delivering to a height of 200 ft.

We could wish that a little more information had been afforded as to the difference in design and dimensions of the three pumps to do this. Centrifugal pumps are a mystery to many engineers. To run efficiently, a centrifugal pump must have a free supply. It will not do to throttle the supply to a centrifugal pump in order to compel it to deliver a certain specified yield. If when fully open a pump delivers more than wanted when run at the speed necessary for the height of delivery, then the pump is too large for its duty. To throttle such a pump will seriously reduce its efficiency, and engineers should be careful not to demand a certain efficiency when specifying quantity, height of delivery and size of pump, because any error in stating the size must render such a demand impossible to fulfil.

Needless to say, no pump will lift water beyond the height corresponding to the temperature of the water. Under partial vacuum, hot or warm water gives off vapour more readily than cold water, and in most cases this property will seriously diminish the lifting power of the pump. Engineers who have not specially studied pumps may refer to the book with advantage.

NOTES ON ACCIDENT PREVENTION.

AN article in *Cassier's Magazine*, by Mr. G. W. Bissell, calls attention to the protection afforded to workmen by guarding machinery properly. We would say that the art of guarding machinery lies in a knowledge of what to guard and what to leave open. We have seen Home Office inspectors insist on the fixing of guards that positively introduced an element of danger not previously present. In other words, one may guard a man into danger by restricting his freedom of action in certain circumstances. There are places of danger into which it is necessary for an authorised person to go from time to time. The guarding of such a place is to be done not by fences and rails near the danger spot, but by fences or lock and key that will keep out the unauthorised person who has sense to be kept out. The fool who will stray into notified danger cannot be guarded against, and deserves very little sympathy when he comes to grief. Gearing on machine tools is a proper object to be guarded; there are few cases where this cannot be done with advantage.

Line shafting is properly guarded when placed overhead out of reach. No more mischievous detail exists than the square headed projecting set screw, or indeed any form of projecting screw or key. The recessed head sunk below the surface of the boss in which it is placed is the only safe thing to use. There is danger even with slot-headed sunk screws, because the use of a screw driver may cause a projecting burr that will take hold of a piece of cloth. A fairly safe form of set screw is the grub screw sunk flush and with a square recess in its head in which a key of the railway door form is used. As much danger arises from work as from the machine tools. A favourite accident in early steam engine days was that of cutting off a turner's hand upon the slide rest of his lathe by means of the sharp edge of the D slide valve he was turning up. Accidents of this type were common. Modern steam engineering work uses simpler forms, but there are still pieces of irregular outline set revolving, and liable to cause accident.

In a list of accidents given by the author, nearly 4,000 in number, close upon 1,100 were due to cleaning machinery in motion, but more than half were accidents connected with lathes. This was under the general head of Machinery and Engine Building.

In the United States there is no care at all of workers, so that statistics are not available. This is carrying things to the other extreme. The American workman has been flattered that he is so much superior to the European native that he does not need grandmotherly care, but, as a fact, he really does need reasonable care as much as any other workman, and ought to get it, for the lot of an injured workman is not, we believe, a happy one in America. But foreign trade has taught the American machine builder to protect dangerous parts, and he now does it for his home trade also.

There is no excuse for not protecting the gears of machine tools and other machines. Covers do not spoil the look of a machine, and they help to keep gears clean, and also prevent articles falling into them. Designers should also bear in mind that where protection cannot be fully given the direction of rotation will exert a most important influence on safety.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London W.C., and at Liverpool, to whom all inquiries should be addressed.

10,822. "Improvements in, or in connection with, overhead wires used for electric traction and similar electric installations." H. CRACKNELL, J. W. CRACKNELL and C. T. PHILLIPS. May 12th.

10,826. "Improvements relating to clockwork-operated electrical switches." F. COLLINS. May 12th.

10,837. "Improvements in and relating to starting switches for electric motors and the like." T. HARRISON and G. A. SMITH. May 12th.

10,840. "An improved form of insulator for electric fittings." C. T. A. HENSHAW. May 12th.

10,856. "Improvements in switchboards for illuminating electric lamp signs, and cards or tickets for automatically actuating the same." M. NORDEN. May 12th. (Complete.)

10,881. "Improvements in electric incandescent lamps with rare earth filaments." W. A. CROOK and E. MINES. May 12th.

10,888. "Improvements in electro-magnetic devices." L. CEREBOTANI and A. SILBERMANN. May 12th. (Complete.)

10,889. "Improvements in or relating to telephone receivers and transmitters." W. C. RUNGE. May 12th.

10,890. "Improvements in or relating to telephone systems and apparatus therefor." W. C. RUNGE. May 12th.

10,899. "Improvements in electric circuit protecting devices." S. Z. DE FERRANTI and C. C. GARRARD. May 12th.

10,934. "Improvements in arc lamps." J. D. F. ANDREWS and ELECTRICAL PRODUCTIONS, LIMITED. May 13th.

10,938. "An improved electric switch." W. WHITE. (F. Rohr, Spain.) May 13th.

10,943. "Improvements in trolley guards." E. GAGNE and P. BONNEAU. May 13th. (Complete.)

10,953. "Improvements in and relating to electric alarms operated by clockwork." E. R. MANNEL. May 13th. (Complete.)

10,957. "Improvements relating to electricity meters." F. LUX. May 13th.

10,971. "Improvements in or relating to electric arc lamps." F. W. LE TALL. (H. Brener, Germany.) May 13th.

10,981. "Improvements in portable incandescent lamps." J. WATTS. May 13th.

11,018. "Improvements in lampholders or sockets as used in lamps for electric lighting and the like." J. W. LEA and J. H. PERRINS. May 14th.

11,021. "Improvements in electricity supply meters." R. KENNEDY. May 14th.

11,044. "Improvements in and connected with electric arc lamps." J. O. GIRDLESTONE and C. F. G. THORKELIN. May 14th. (Complete.)

11,068. "Improvements in apparatus for actuating the electrical controlling appliances of the motors of electric railway motor cars." SIEMENS BROS. & CO., LTD. (Siemens & Halske, Actien-Gesellschaft, Germany.) May 14th.

11,072. "Improvements in switches for electric circuits." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. J. Wood, United States.) May 14th. (Complete.)

11,073. "Improvements in means for controlling electric circuits." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. J. Wood, United States.) May 14th. (Complete.)

11,074. "Improvements in winding forms." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (J. W. Sundskog, United States.) May 14th, (Complete.)

11,075. "Improvements in electric switches." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. M. Hewlett, United States.) May 14th. (Complete.)

11,076. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. W. Rice, jun., United States.) May 14th. (Complete.)

11,077. "Improvements in supports for high-tension electric conductors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. F. Batchelder, United States.) May 14th. (Complete.)

11,078. "Improvements in electric arc lamps." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. C. Fish, United States.) May 14th. (Complete.)

11,079. "Improvements in cut-outs for electric conductors," THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (P. G. Watmough, jun., United States.) May 14th. (Complete.)

11,080 "Improvements in multipolar electric switches." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (H. R. Sargent, United States.) May 14th. (Complete.)

11,081 "Improvements in electric starting rheostats." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. Mackintosh, United States.) May 14th. (Complete.)

11,082. "Improvements in third-rail insulators for electric railways." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (S. B. Stewart, jun., United States.) May 14th. (Complete.)

11,085. "Improvements in electric cranes." STOTHERT & PITT. May 14th.

11,086. "Improvements in and relating to electric switches." D. R. BROADBENT. May 14th.

11,095. "Improvements in or relating to coupling devices particularly applicable for coupling a dynamo to a centrifugal pump." M. A. EUDELIN. May 14th

11,101. "Improvements in electric clocks." O. ROMANZE. May 14th.

11,102. "Improvements relating to electric heaters and rheostats." M. C. KRUEGER. May 14th. (Complete.)

11,127. "Improved apparatus or means to be employed in conjunction with trolley arms in applying roofs or covers over the tops of electric tramcars and the like." J. T. TRAINER. May 15th.

11,134. "Improvements in electric arc lamps." A. ECKSTEIN and A. E. ANGOLD. May 15th.

11,139. "Improvements in or relating to the electrical igniters of gas and similar explosive vapour motors." H. R. BELLANNY. May 15th.

11,159. "Spring roller for regulating the height of electric light pendants." W. EMERSON. May 15th.

11,160. "Improvements in electric arc lamps." A. KIRBY and A. J. KIRBY. May 15th.

11,165. "Improvements in switch-box apparatus used for testing, standardising, or calibrating electrostatic instruments, and in measuring electric currents thereby." G. L. ADDENBROOKE. May 15th. (Complete.)

11,177. "Improvements in apparatus for opening and closing electric circuits." H. HIRST and C. F. TRIPPE. May 15th.

11,188. "Improvements in continuous current dynamos." P. NETY. May 15th.

11,197. "Extracting electricity from the atmosphere and storing it." J. FENTON, A. DU LAC, and A. JONCKHEERE. May 15th.

11,206. "Improvements in or relating to arc lamps." F. ENGELHARDT. May 15th.

11,209. "Improvements relating to electrical conduit systems for tramways." ASPINALL and J. D. DALLAS. May 15th.

11,240. "Improved electric switch." J. C. MACALESTER. May 16th.

11,249. "Improved sliding pendant for electric lighting." J. MILNE. May 16th.

11,269. "Improvements in wireless signalling." J. MUNRO. May 16th.

11,286. "A new or improved galvanic cell." G. B. PUCHMULLER and G. PEARSON. May 16th. (Complete.)

11,290. "Improvements in electric switches and regulating sockets, chiefly designed for use in connection with incandescent electric lamps." H. H. LAKE. (W. P. Pinckard, United States.) May 16th. (Complete.)

11,313. "Improvements in and relating to the transmission of electrical impulses." L. WALTER and P. WALTER. May 16th.

11,323. "Improvements in electricity meters." L. J. ARON and J. W. FLOWER. May 16th.

11,324. "Improvements in electricity meters of the kind known as two-rate meters." L. J. ARON and J. W. FLOWER. May 16th.

11,339. "Improvements in portable telephonic apparatus for use of persons of impaired hearing." W. E. HEYS. (The Hutchison Acoustic Company, U.S.A.) May 16th. (Complete.)

11,340. "Improvements in any or semi-dry cells of primary or secondary electric batteries." (The Hutchison Acoustic Company, U.S.A.) May 16th. (Complete.)

11,342. "Improvements in charging switches for secondary electric batteries." W. E. HEYS. (The Hutchison Acoustic Company, United States. May 17th. (Complete.)

11,357. "Improvements in electricity meters." K. ANDERSON. May 17th.

11,369. "Improvements in electric governing devices." J. J. O'CONNOR and W. O. S. HILDITCH. May 17th.

11,372. "Improvements in the manufacture of earthenware sanitary pipes cable conduits and other like objects." R. STANLEY. May 17th.

11,374. "A new system of electric traction." B. CRUVELLIER. May 17th (Complete.)

11,377. "Improvements in fittings for metallic conduit systems of electric wiring." L. M. WATERHOUSE and THE SIMPLEX STEEL CONDUIT COMPANY, LIMITED. May 17th. (Complete.)

11,393. "Improvements in automatic apparatus for controlling and operating the points of electric railways and tramways." T. B. STEWART, W. H. TURNER, and R. E. DIXON. May 17th.

11,395. "Improvements in or applicable to rheostat switches for controlling electric currents." W. R. LAIDLAW and G. H. SCHOLES. May 17th.

11,404. "Improvements in electric fuses." O. L. PEARD. May 17th.

11,416. "Improvements in overhead conductors for electric tram and railways." E. DUSSEK. May 17th.

11,427. "A new or improved endless electric conveyor for conveying tin plates from the bath of molten metal to a suitable or desirable place." J. B. O. CLARE and C. HILLMAN. May 17th. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d (in stamps).

1900.

5,693. "Improvements in and relating to telephonic systems." M. C. Mengis and F. S. Christensen. Dated March 27th, 1900. Telephone instruments are connected by means of a single line, including condensers in series, or by two parallel lines, each attached to a telephone set and provided with a dead end. The two lines may consist of the wires of a submarine cable. 5 claims.

5,698. "Improvements in the method of and means for protecting electrical connections." J. Langton. Dated March 27th, 1900. The electrode of an elertrolytic or galvanic cell is provided with a rod or bar, the other end of which is preferably furnished with a shoe, and rests upon an insulated metal tray, which is the permanent terminal of one of the line conductors. The tray contains water or other liquid, which is capable of dissolving and holding in solution any salts that may be deposited into it, such as creepings, splashings, or drippings. Other forms of connection may be adopted, provided the contact surfaces are submerged. 5 claims.

5,710. "Improved indicator for storage batteries." P. J. S. Tiddeman. Dated March 27th, 1900. Relates to current meters for indicating the exhaustion of the individual cells of a storage battery. Each cell is permanently connected through a fuse to a separate electro-magnet, which normally is able to support an armature lever, but allows this to drop if the cell pressure falls below any desired limit, adjusted by a distance screw set in the armature. Each lever carries an indicating plate behind a numbered openings in a front plate, and may also close the circuit of an electric bell by contact with a step. The levers may be hung from pivots, or hinged below the electro-magnets. 3 claims.

5,727. "Improvements in electric heating and apparatus therefor." J. A. C. Trudeau. Dated March 27th, 1900. Relates to electric heating applicable to the heating of liquids or vessels containing foods or other articles, to water and steam radiators, water and steam boilers, &c., in which a liquid or chemical solution of naturally low resistance is employed as the resistance or heating medium. 4 claims.

5,743. "Improvements in or relating to the mechanism for controlling and indicating temperature limits." E. H. Griffiths, W. C. D. Whetham, and the Cambridge Sentinel Manufacturing Company. Dated March 27th, 1900. In an apparatus for indicating temperature limits and applicable to fire alarms, a quantity of fusible metal, alloy, or other substance is arranged in a receptacle in such a way that, when the temperature limit is reached, it melts, and the action of gravity or a spring causes the alloy, &c., to close an electric circuit so as to sound a bell, &c., alarm or perform some other function. 6 claims.

5,751. "Improvements in or in connection with storage batteries." E. A. Sperry. Dated March 27th, 1900. Relates to a cell which is formed by burning lead sheets together, and is in one with the negative fastened to the inner walls of the cells. 27 claims.

5,755. "Improvements in the manufacture of electrical insulating material." C. Jung, A. Brecher and A. Kittel. Dated March 27th, 1900. Casein is kneaded with oils with or without sulphur, and is afterwards mixed with gutta-percha or other suitable material. The whole may be vulcanised or not, and may be coloured. The oils preferred are castor, rape or linseed. 6 claims.

5,754. "Means for retaining the field magnet coils of electric motors and dynamos in position." C. A. Lindstrom. Dated March 27th, 1900. Relates to means for retaining the field coils of electric motors and dynamos in position. The coils which fit over the holes are secured to the frame by means of wedge-shaped blocks of wood or other non-conducting material, through which and through the frame pass bolts of non-magnetic material, provided at their outer ends with nuts by means of which the parts may be adjusted. 4 claims.

5,786. "Improvements in electric cables." G. H. Nisbett. Dated, March 28th, 1900. Multiphase current systems are provided with cables in which the various phases are balanced by means of the various arrangement of conductors. One arrangement is described in which two sector conductors are surrounded by two annular stranded conductors. The central conductors may vary in number and shape. 2 claims.

5,806. "Improvements in the regulation of dynamo-electric machines." British Thomson-Houston Company. (C. P. Steinmetz.) Dated March 28th, 1900. Double-current generators are automatically regulated by means responsive to variations of load in both the continuous current and the alternating current circuits. The generator from which proceeds the direct current leads and the three-phase leads is provided with a compound winding, consisting of a shunt coil and a series coil, so as to compensate for the demagnetising effect of the direct current armature reaction. To compensate for the effects of the alternating current armature reaction, a rotary converter is connected to the three-phase leads, the said converter being provided with a series winding as well as a shunt winding. In addition to this, reactance coils are inserted in the three-phase leads. Alternatively, a synchronous motor may be connected to the three-phase leads, the motor field being provided with two windings, one of which is supplied with a direct current through a rectifier, and the other from an exciter. 9 claims.

5,841. "Improvements in electricity meters." M. C. Clutterbuck. Dated March 28th, 1900. Mercury voltameters are made with porous diaphragms to support the mercury anodes above the cathodes. In the form described, the porous diaphragm is supported on a shoulder the glass enclosing vessel, below a platinum connecting wire; the cathode is a platinum wire in the lower part of the vessel where mercury is deposited and measured on an adjacent scale. 7 claims.

5,848. "Improvements in conduits and conductor supports for electric tramways." M. H. Smith. Dated March 29th, 1900. Relates to electric railways and tramways on the conduit system. The boxes or chairs which carry the rails and the conductors in the conduit are built up of channel and girder sections of wrought-iron or steel, closed at the end by plates with flanges or angle irons. The various parts are riveted together and the sections are cut out for the conduit. Cover plates are placed on the top and the box may be extended at one side for the hand hole cover. 5 claims.

5,860. "Improvements in electrical apparatus for hoisting and other intermittent work." W. H. Scott. Dated March 29th, 1900. Relates to apparatus for starting, stopping and governing the speed of electric motors employed for hoisting or other intermittent work. 6 claims.